IMPROVED
MOBILE TELEPHONE SYSTEM

152-162 MC 20 W RF POWER

±12 VOLT SYSTEMS

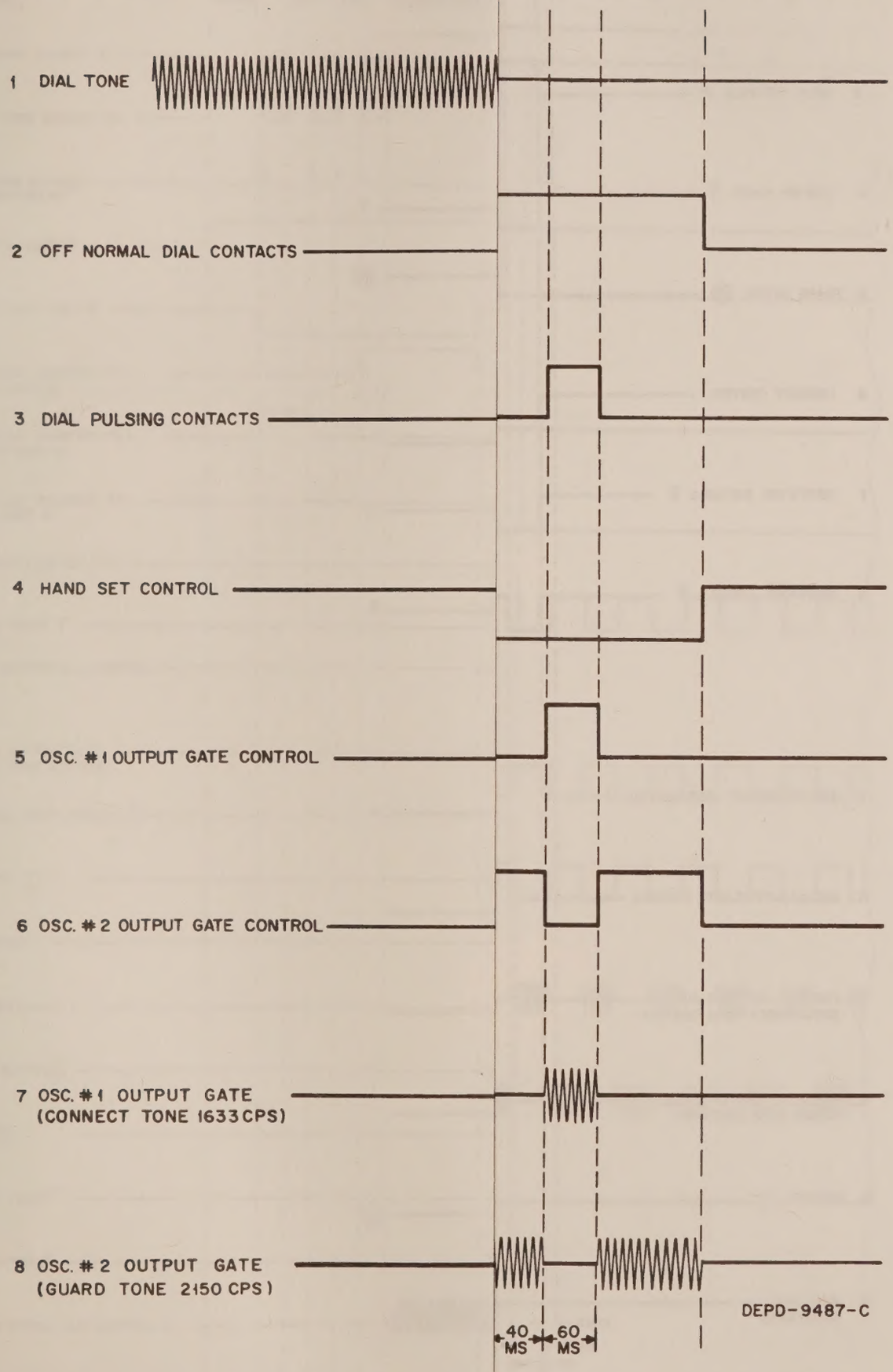
T-1234A	T-1279AH
T-1245A	T-1284A
T-1246AH	T-1285A
T-1258AH	T-1286AH
T-1262AH	

68P81022A65

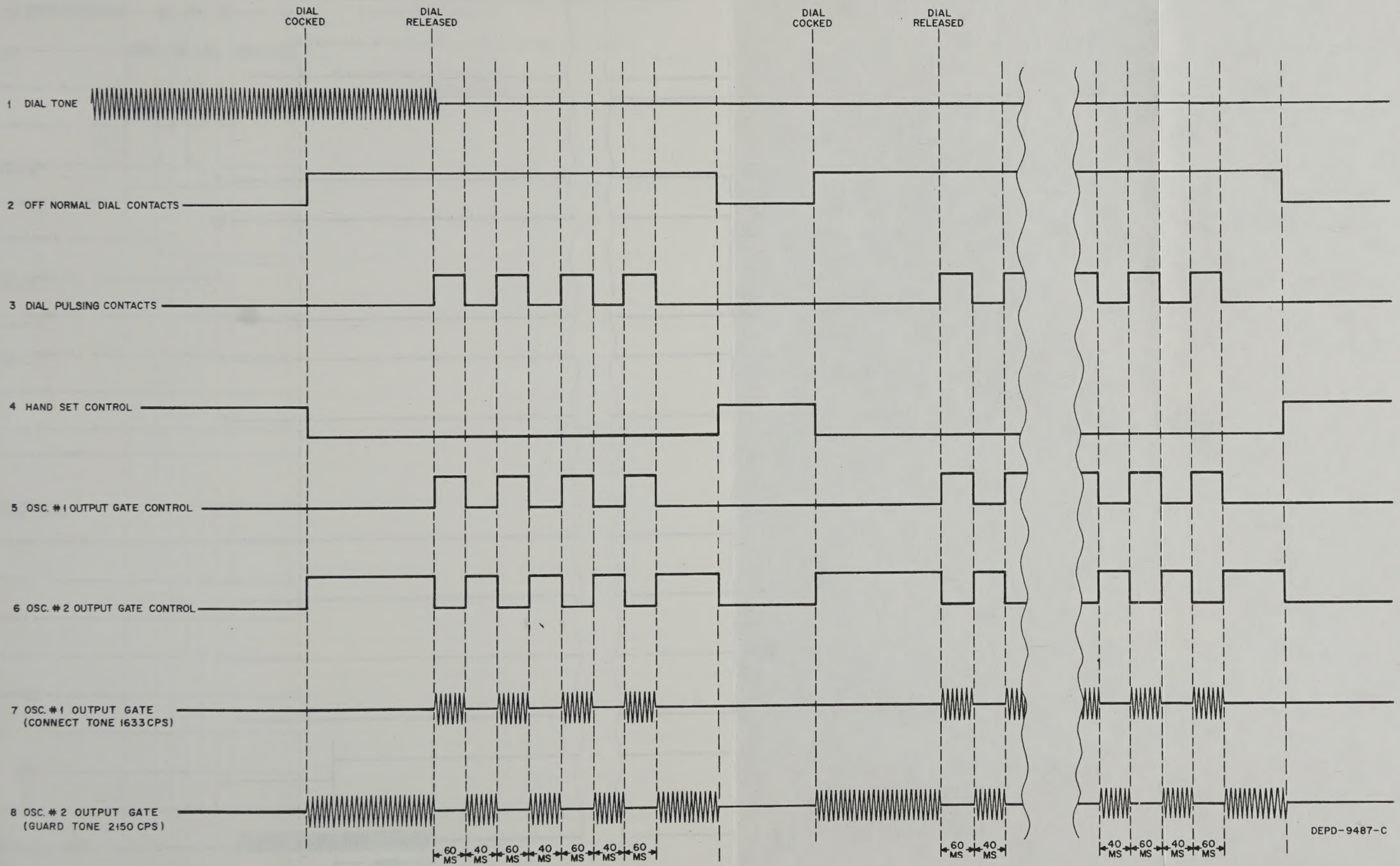


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Amateur Radio Digital Communications, Grant 151

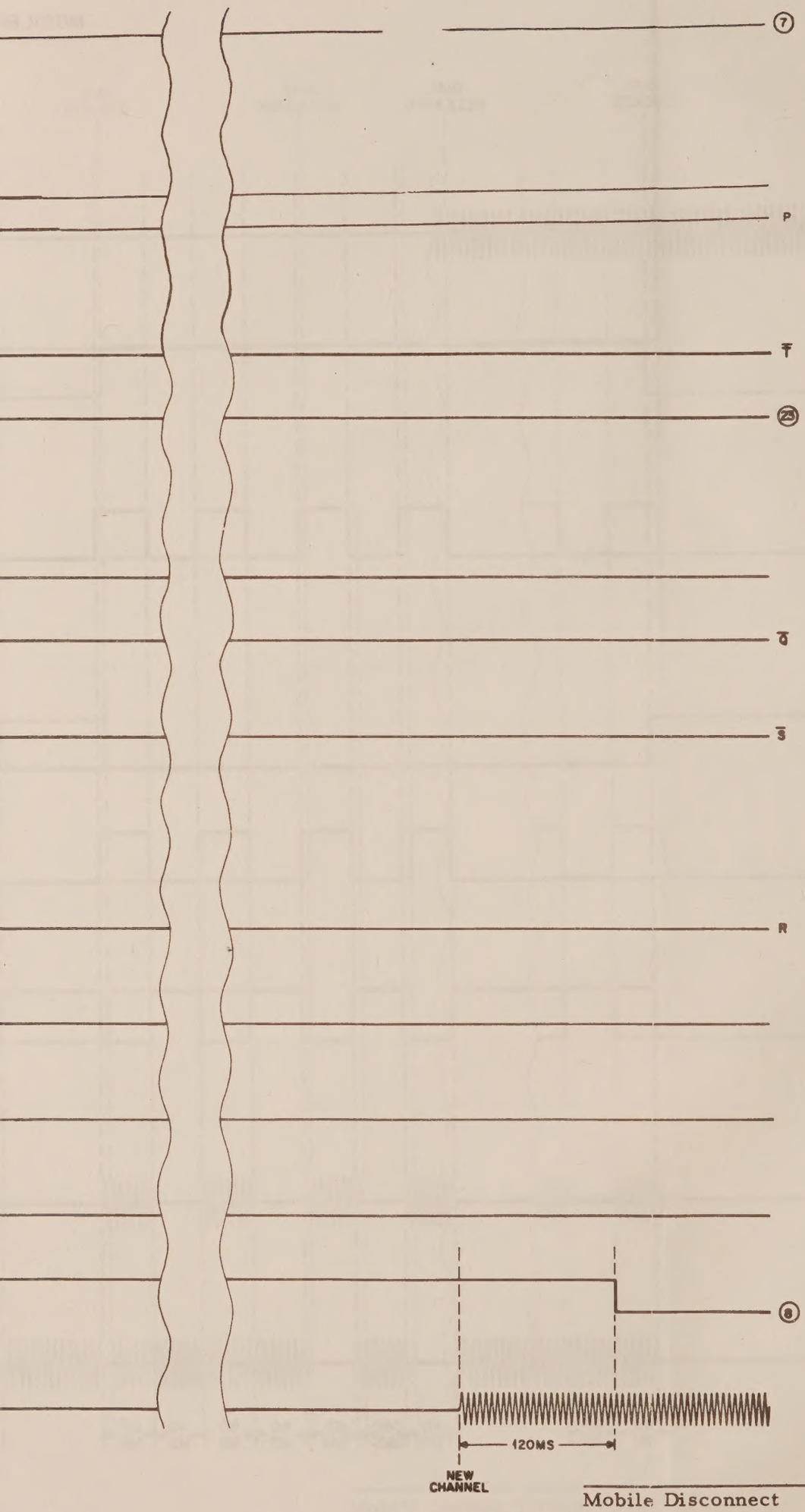
https://archive.org/details/improvedmobilete00unse


CO
1 DIAL TONE
2 OFF NORMAL DIAL CONTACTS
3 DIAL PULSING CONTACTS
4 HAND SET CONTROL
5 OSC. #1 OUTPUT GATE CONTROL
6 OSC. #2 OUTPUT GATE CONTROL
7 OSC. #1 OUTPUT GATE
(CONNECT TONE 1633 CPS)
8 OSC. #2 OUTPUT GATE
(GUARD TONE 2150 CPS)
DEPD-9487-C
40 MS
60 MS
DC
Sets

MOBILE DIALING



Mobile Dialing Timing Chart
For 152-162 MC, 20 W, ±12 VDC
Motorola Car Telephone Radio Sets
And IMTS Control Terminal
Motorola No. DEPD-9487-C



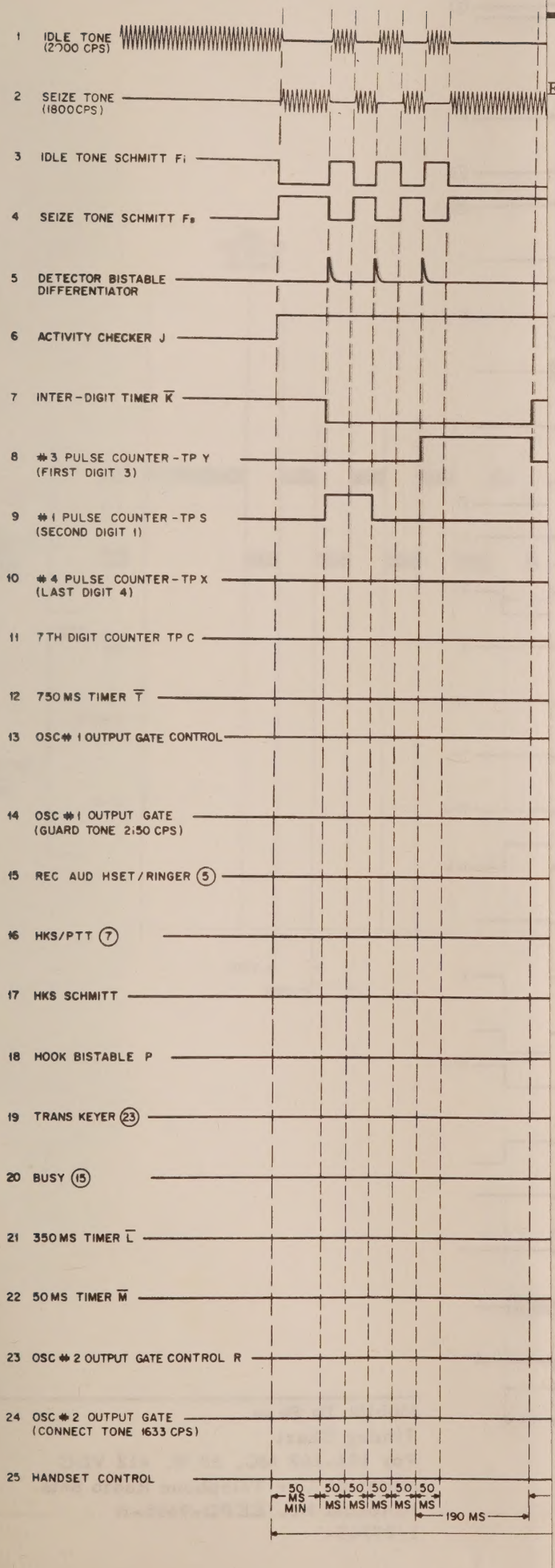
Mobile Disconnect
Timing Chart
For 152-162 MC, 20 W, ±12 VDC
Motorola Car Telephone Radio Sets and
IMTS Control Terminal
Motorola No. EEPD-9488-C
8/16/65-

manual revision T-1951J

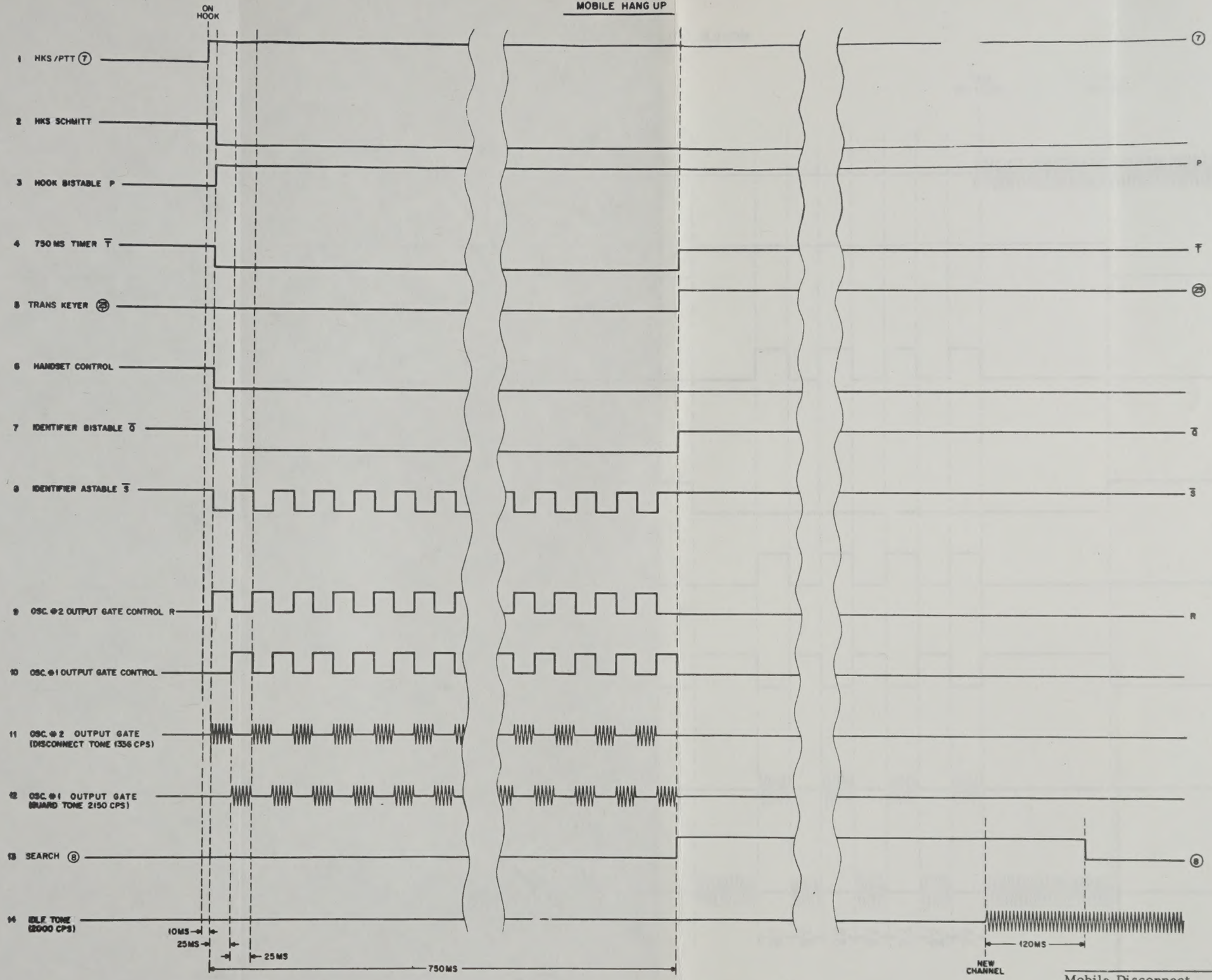
For 68P81029A35-O

EPD-9486-B to your Supervisory Unit Section.

Also used in 68P81022A65
68P81028A60



Base to Mobile
Timing Chart
For 152-162 MC, 20 W, ±12 VDC
Motorola Car Telephone Radio Sets and
IMTS Control Terminal
Motorola No. EEPD-9486-B
8/16/65-



Mobile Disconnect
Timing Chart
For 152-162 MC, 20 W, ±12 VDC
Motorola Car Telephone Radio Sets and
IMTS Control Terminal
Motorola No. EEPD-9488-C
8/16/65-

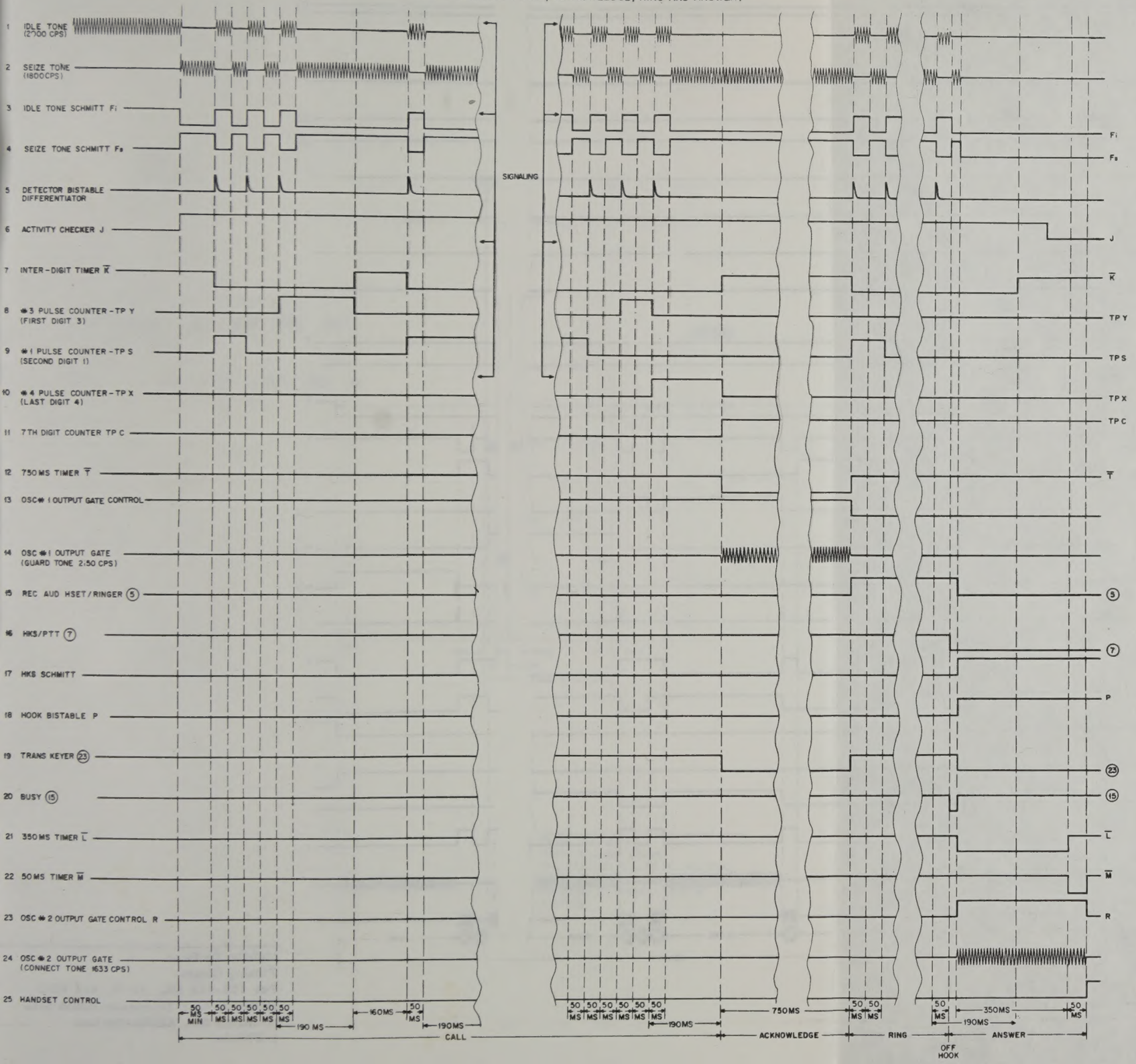
instruction manual revision T-1951J

For 68P81029A35-O

Add this EPD-9486-B to your Supervisory Unit Section.

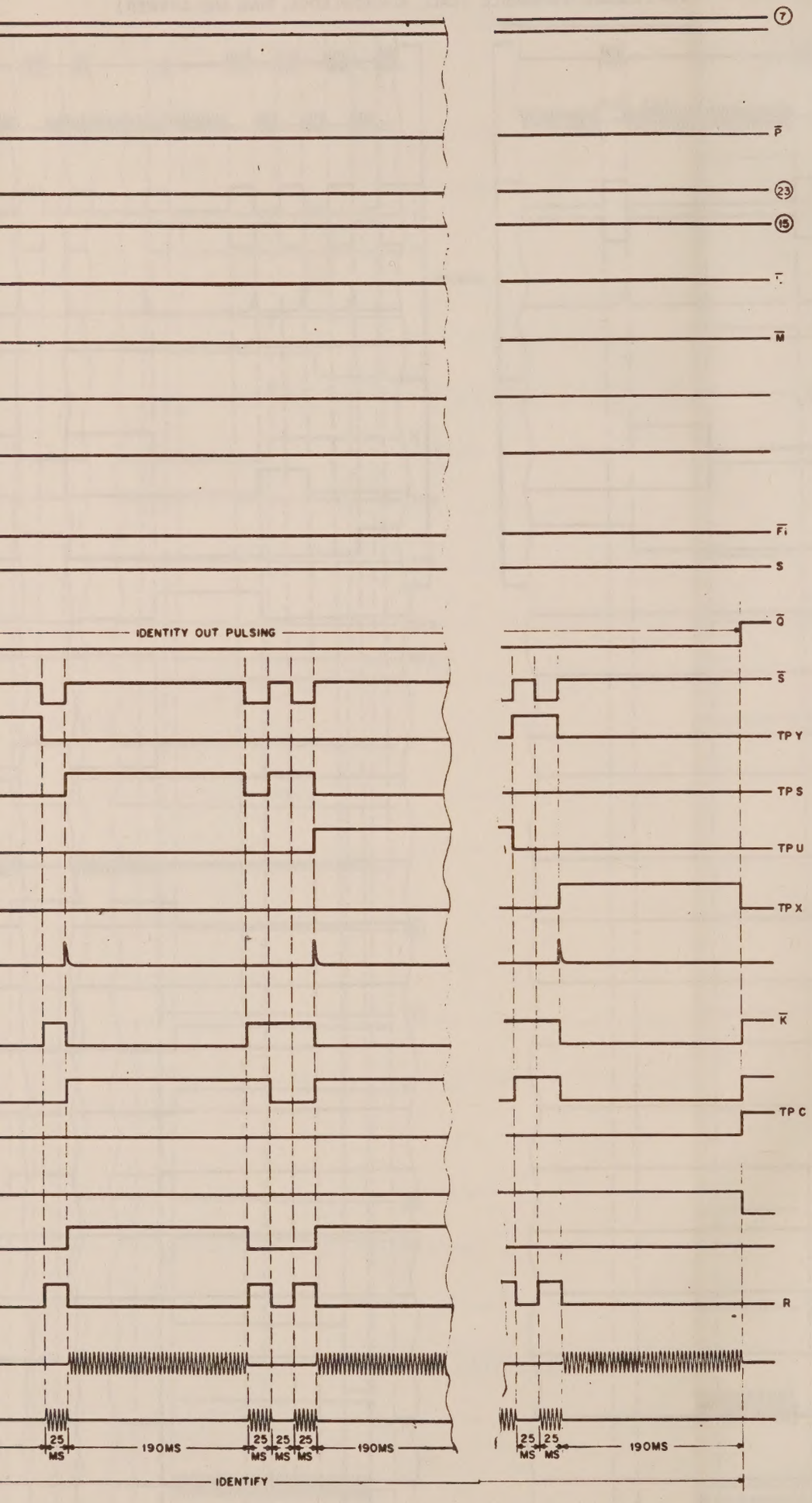
Also used in 68P81022A65
68P81028A60

BASE TO MOBILE (CALL, ACKNOWLEDGE, RING AND ANSWER)

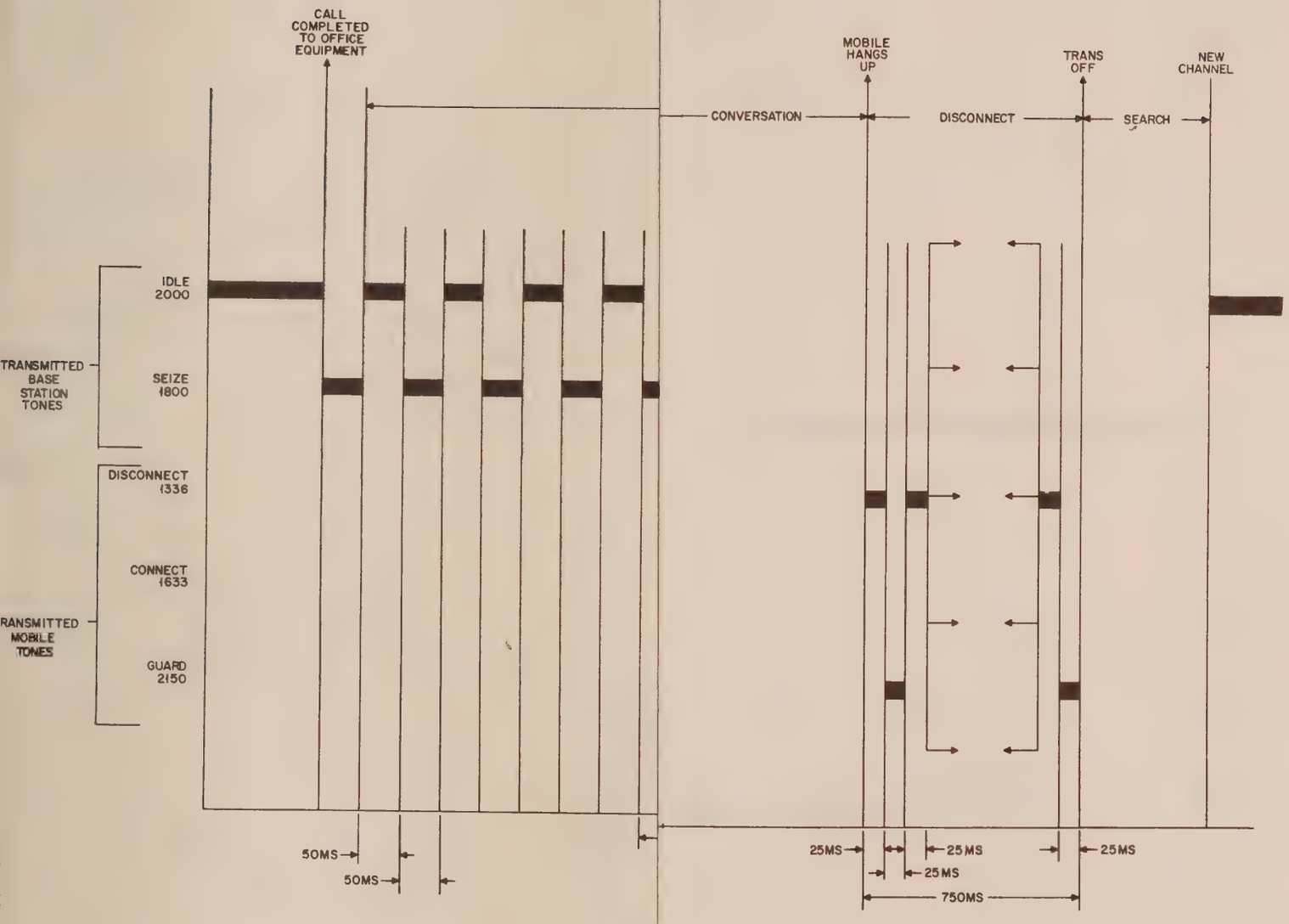


Base to Mobile
Timing Chart
For 152-162 MC, 20 W, ±12 VDC
Motorola Car Telephone Radio Sets and
IMTS Control Terminal
Motorola No. EEPD-9486-B
8/16/65-

USED IN CAR TELEPHONE
DIAGRAM BOOKLET
68P81022A65
68P81028A60



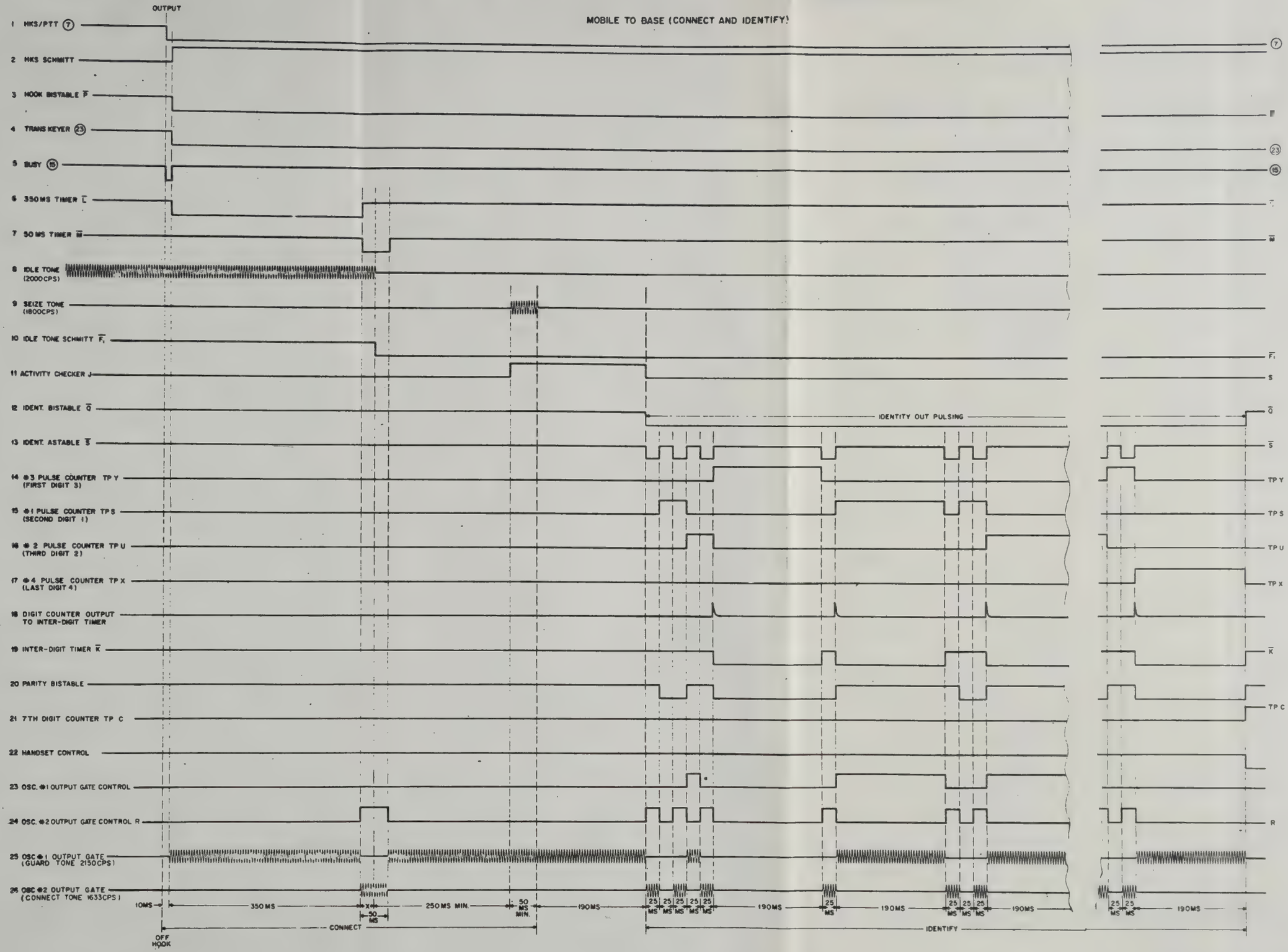
Mobile To Base
Timing Chart
For 152-162 MC, 20 W, ±12 VDC
Motorola Car Telephone Radio Sets
Motorola No. EEPD-9485-B
1/27/65-



Base To Mobile
Tone Sequence Chart
For 152-162 MC, 20 W, ±12 VDC
Motorola Car Telephone
Motorola No. EEPD-9490-B
1/27/65.

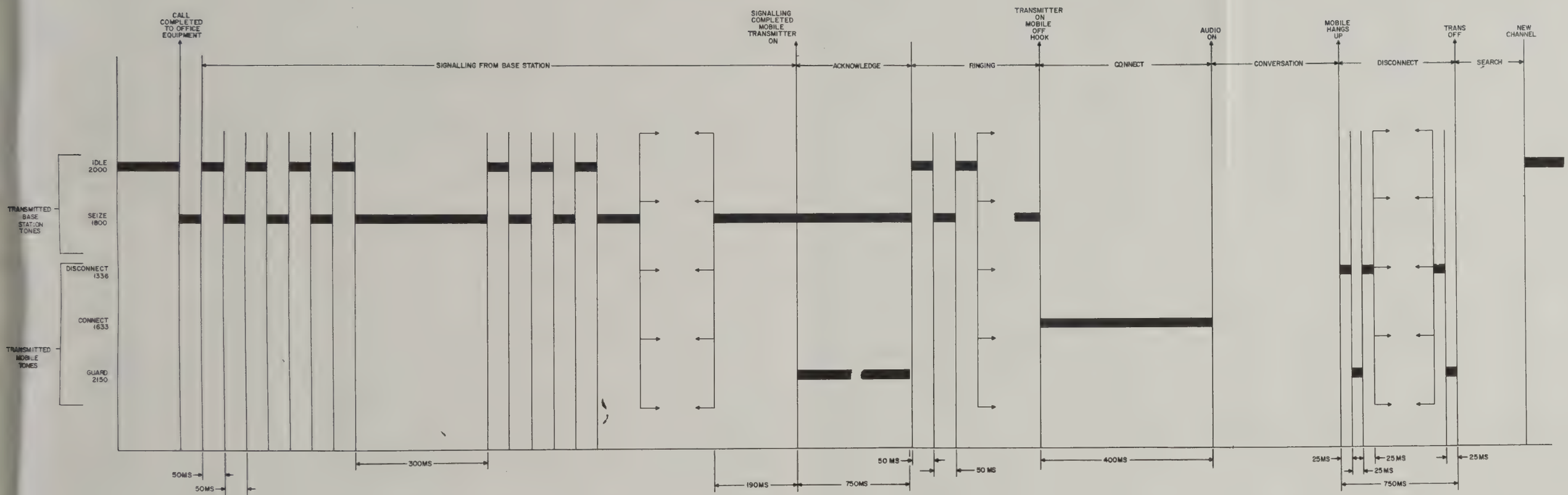
USED IN CAR TELEPHONE
DIAGRAM BOOKLET
68P81022A65
68P81028A60

MOBILE TO BASE (CONNECT AND IDENTIFY)



Mobile To Base
Timing Chart
For 152-162 MC, 20 W, ±12 VDC
Motorola Car Telephone Radio Sets
Motorola No. EEPD-9485-B
1/27/65-

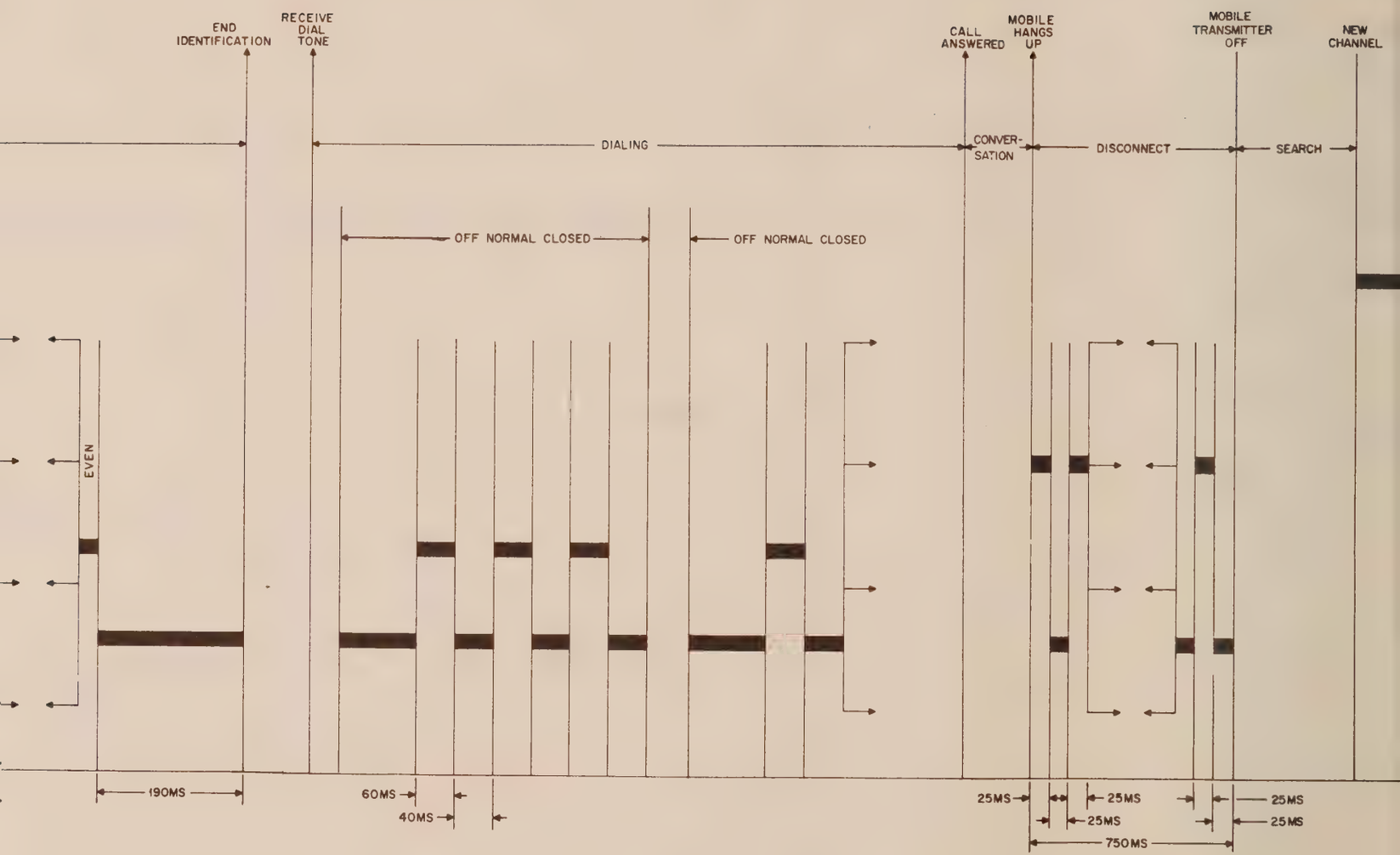
BASE STATION TO MOBILE CALL



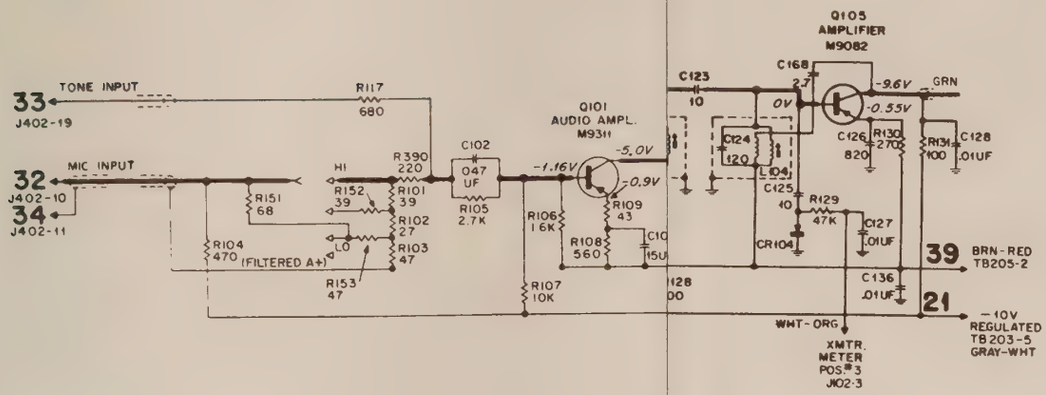
Base To Mobile
Tone Sequence Chart
For 152-162 MC, 20 W, ±12 VDC
Motorola Car Telephone
Motorola No. EEPD-9490-B
1/27/65.

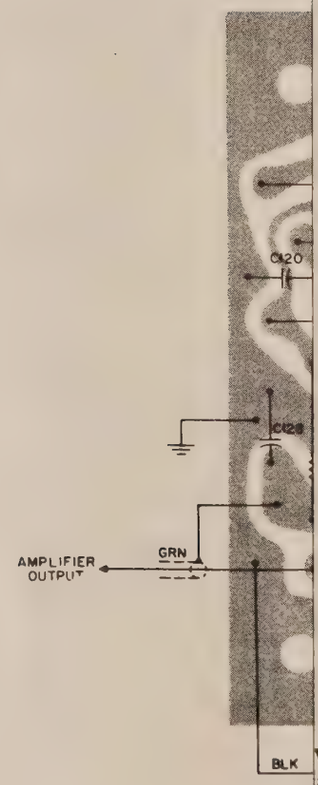
USED IN CAR TELEPHONE
DIAGRAM BOOKLET
68P81022A65
68P81028A60

ASE STATION CALL



Mobile To Base
Tone Sequence Chart
For 152-162 MC, 20 W, ±12 VDC
Motorola Car Telephone Radio Se
Motorola No. EEPD-9489-B
1/27/65-

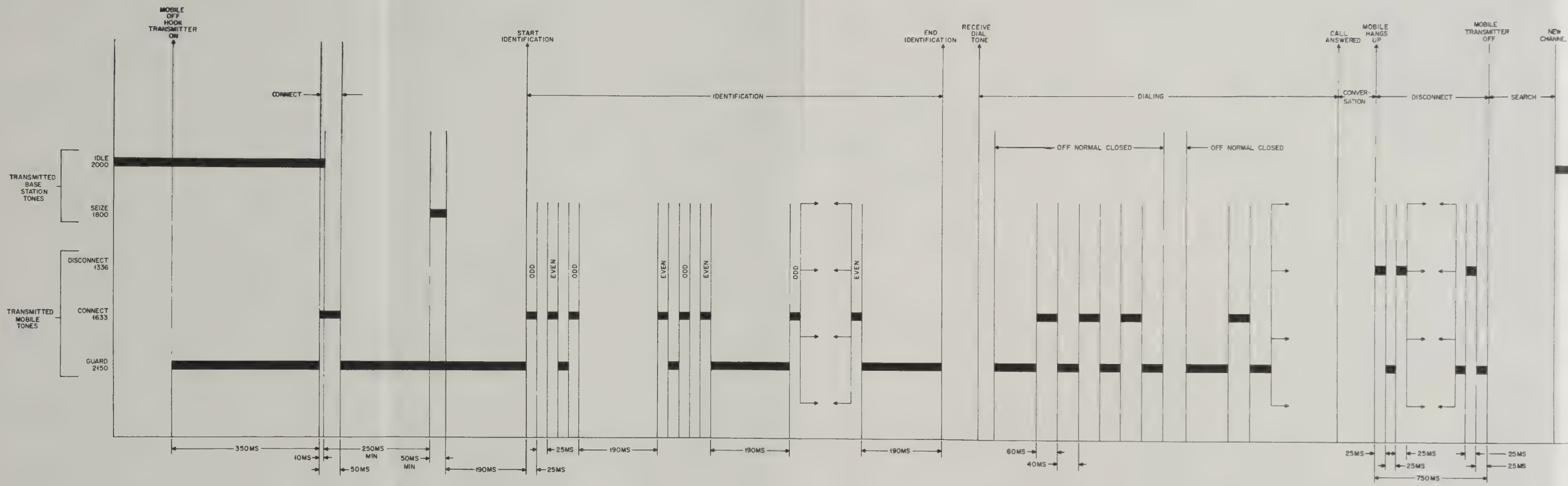




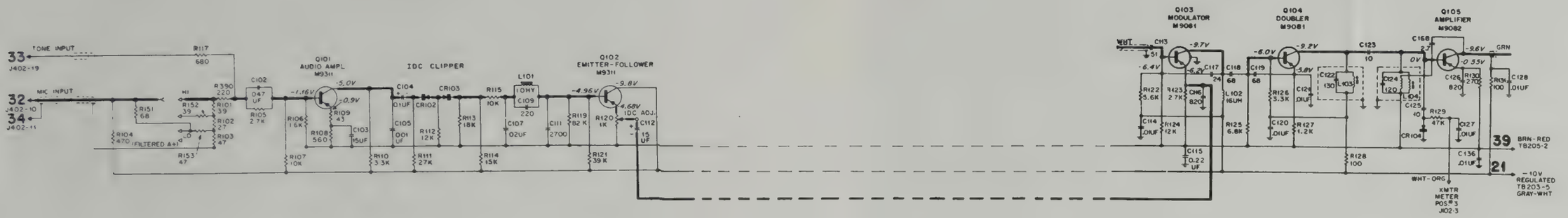
VIOUS REVISIONS AND PARTS LIST
WN ON BACK OF THIS DIAGRAM

162 MC Car Telephone Radio Set
el TLD6300B-4 Audio Exciter Board
uit Board Detail
rola No. EPD-9978-H (SMR-524C)
/69.

MOBILE TO BASE STATION CALL



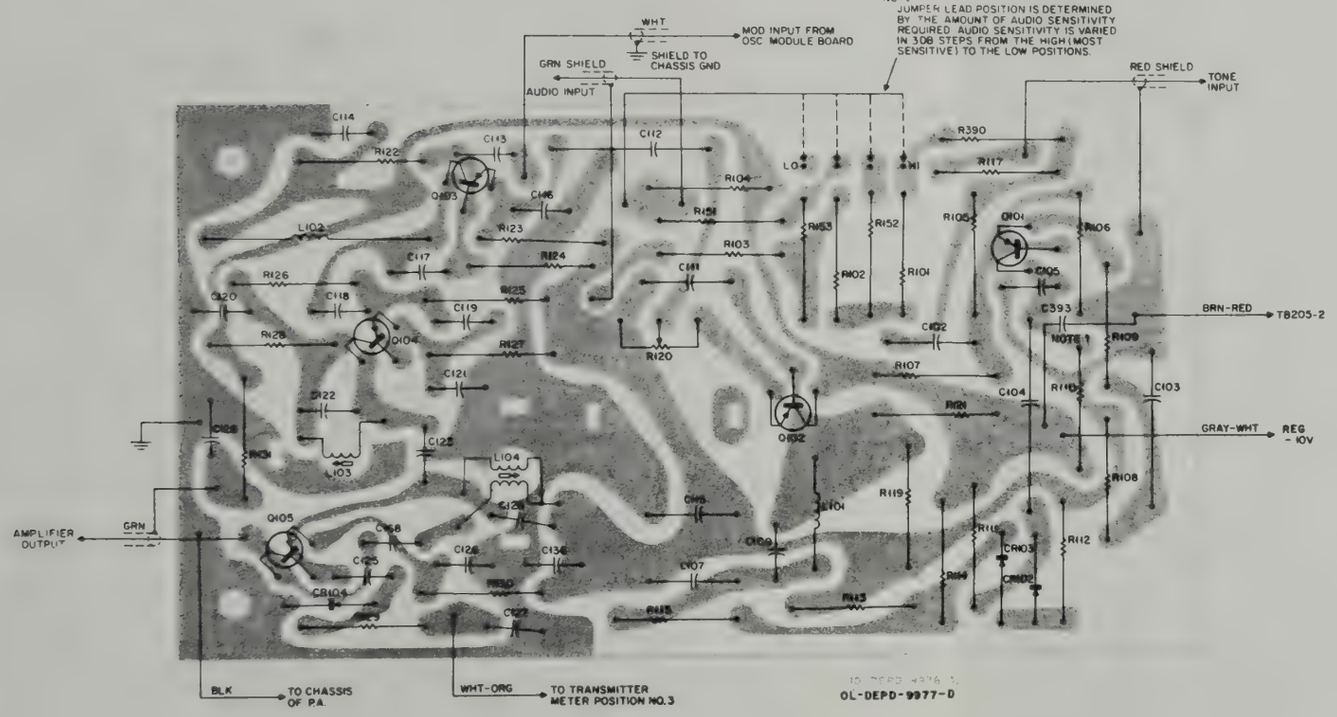
Mobile To Base
Tone Sequence Chart
For 152-162 MC, 20 W, ±12 VD
Motorola Car Telephone Radio
Motorola No. EEPD-9489-B
1/27/65-



THIS COMPONENT OVERLAY REQUIRES CIRCUIT BOARD DEPD-9976

NOTE

JUMPER LEAD POSITION IS DETERMINED BY THE AMOUNT OF AUDIO SENSITIVITY REQUIRED. AUDIO SENSITIVITY IS VARIED IN 30B STEPS, FROM THE HIGH (MOST SENSITIVE) TO THE LOW POSITIONS.



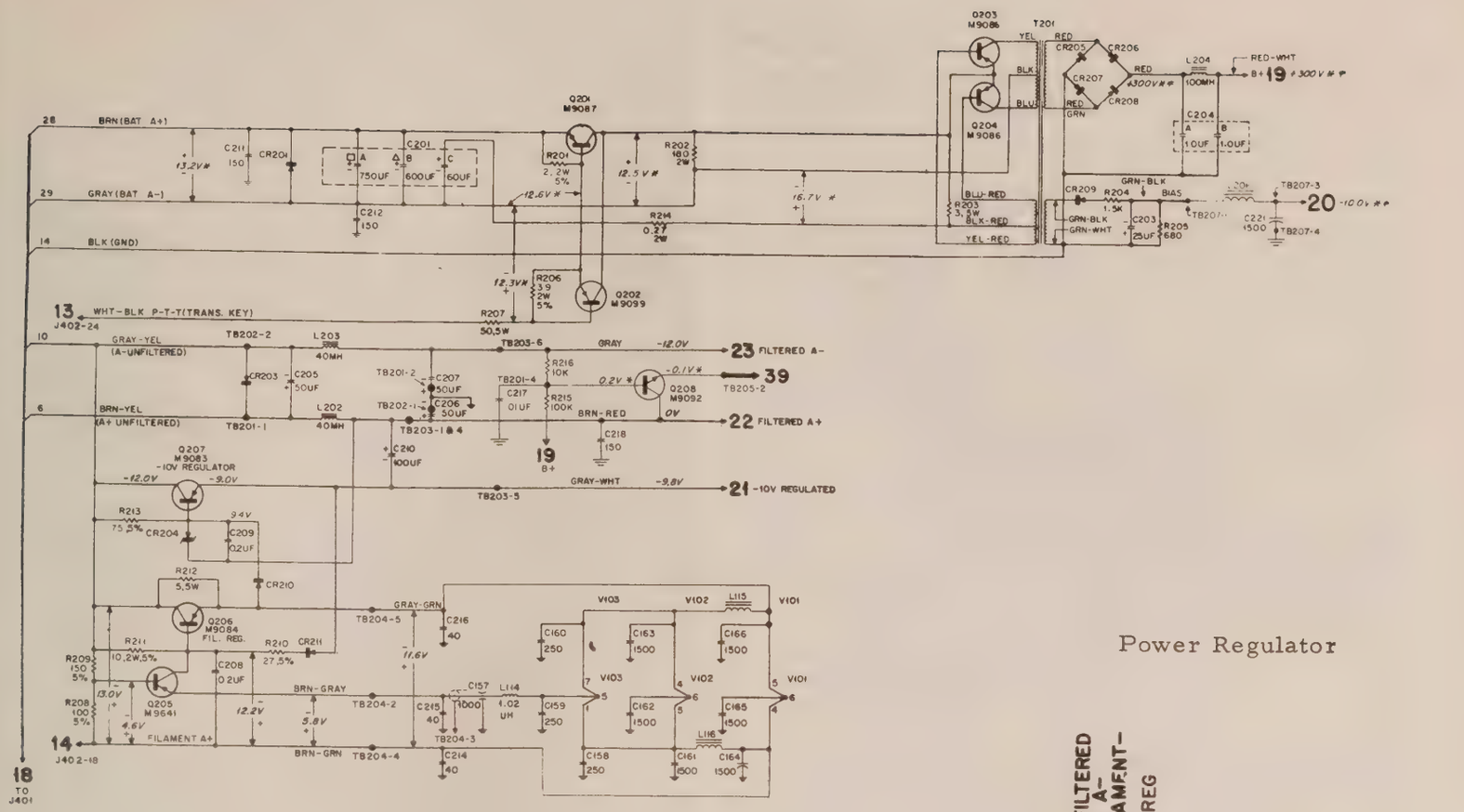
OL-DEPD-9977-D

NOTE:

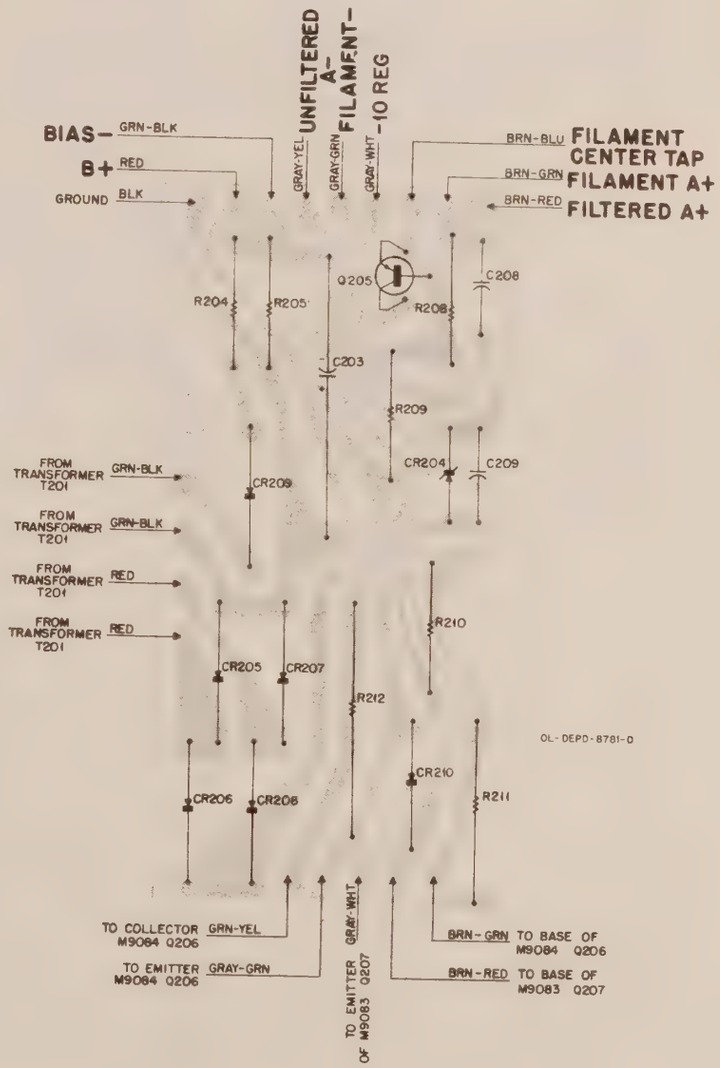
1. CAPACITOR C393 IS USED WITH RADIO COMMON CARRIER MODELS ONLY.

PREVIOUS REVISIONS AND PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

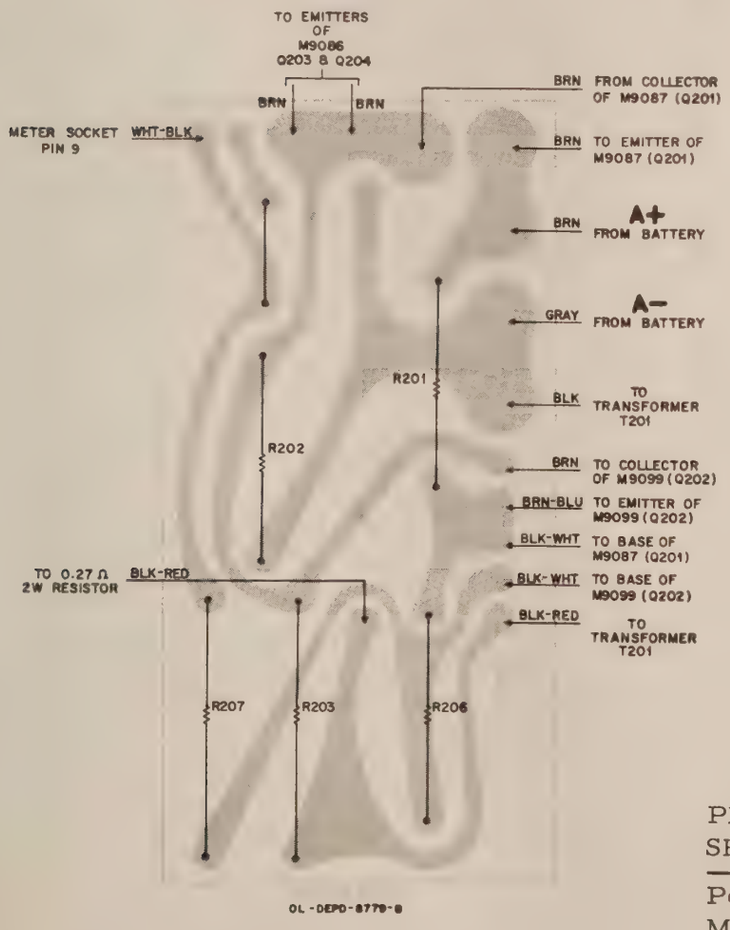
152-162 MC Car Telephone Radio Set
Model TLD6300B-4 Audio Exciter Board
Circuit Board Detail
Motorola No. EPD-9978-H (SMR-524C)
9/18/69.



Power Regulator



Power Supply



PREVIOUS REVISIONS AND PARTS LIST
SHOWN ON BACK OF THIS DIAGRAM

Power Supply and Regulator Circuit Board Details
Model TPN6046A-2 used in 152-162 MC, 20 W, ±12 V DC
Motorola Car Telephone Radio Set
Motorola No. EPD-8782-K (SMR-868E)
7/9/71-

REVISIONS

EPD-9978-H

BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
TLD6300B		ADDED 68P81022A65	DIAGRAM BOOKLET LIST
TLD6300B-1		JUMPER REMOVED. WAS CONNECTED BETWEEN JUNC - TIONS R103, R104 AND R106, R108	
TLD6300B-1	R113, 114	TRANSPOSED	PARTS LIST
TLD6300B-2	Q101, 102	WERE 48R869080 TYPE M9080	Q101, Q102
	R121	WAS 6R6434, 27K	Q102 BASE
	R119	WAS 6R6048, 47K	
TLD6300B-3	C104	WAS 23D82601A11, 5 uf	Q101 COL- LECTOR
	C107	WAS 8D82905G21, .018 uf	IDC CLIPPER CIRCUIT
	C109	WAS 21D82133G03, 100 uuf	Q102 BASE
	R105	WAS 6R5581, 3.3K	Q101 BASE
	R109	WAS 6R5614, 56 OHMS	Q101 EMIT- TER
TLD6300B-3	R393	ADDED .01 uf	BELOW Q101
	R105	WAS 6R5577, 2.7K	Q101 BASE
	R106	WAS 6R6038, 1.5K	
	R109	WAS 6R5550, 47	Q101 EMITTER
	R110	WAS 6R5581, 3.3K	Q101 COL- LECTOR
TLD6300B-4			

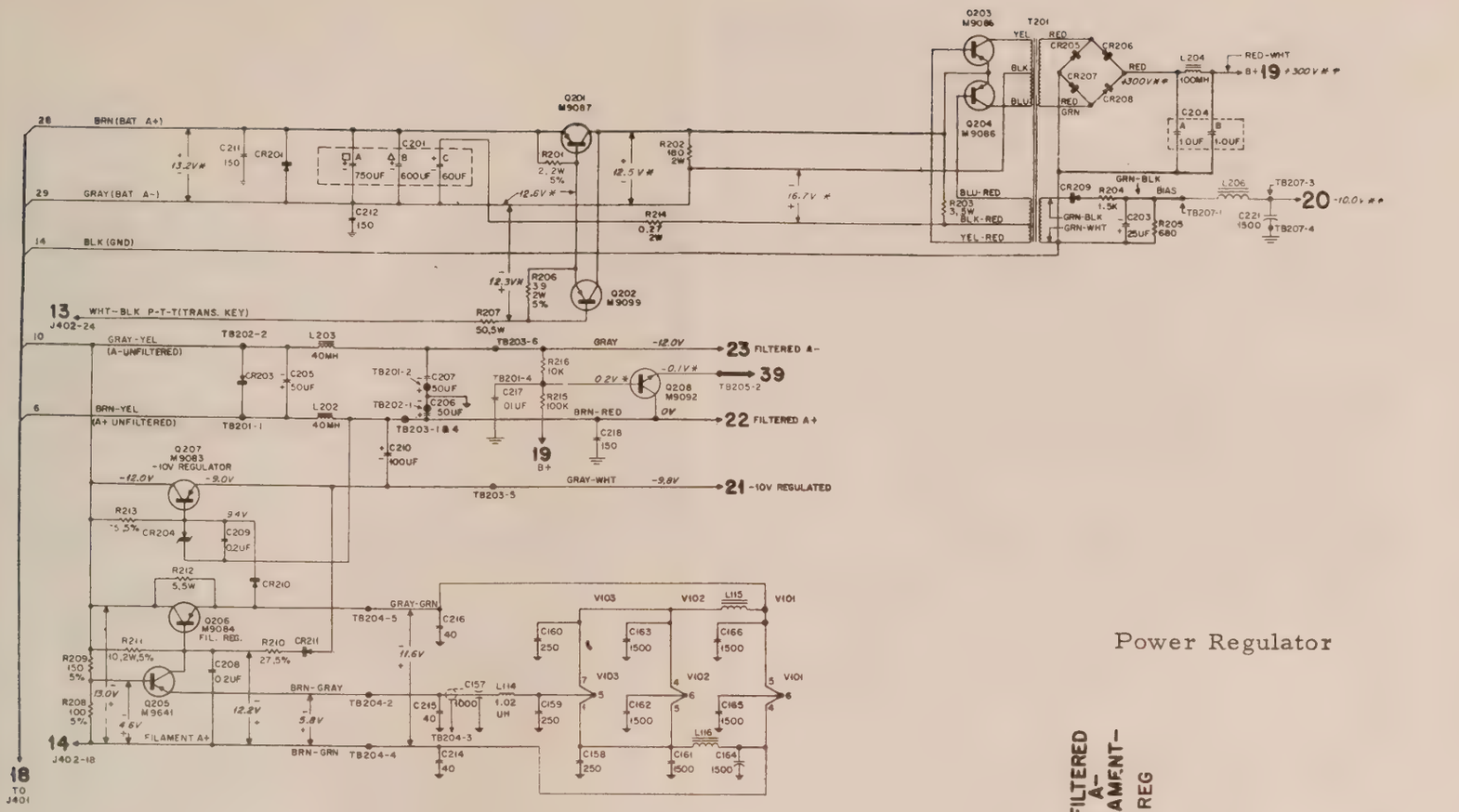
PARTS LIST

TLD6300B Exciter Circuit Board PL-623-O

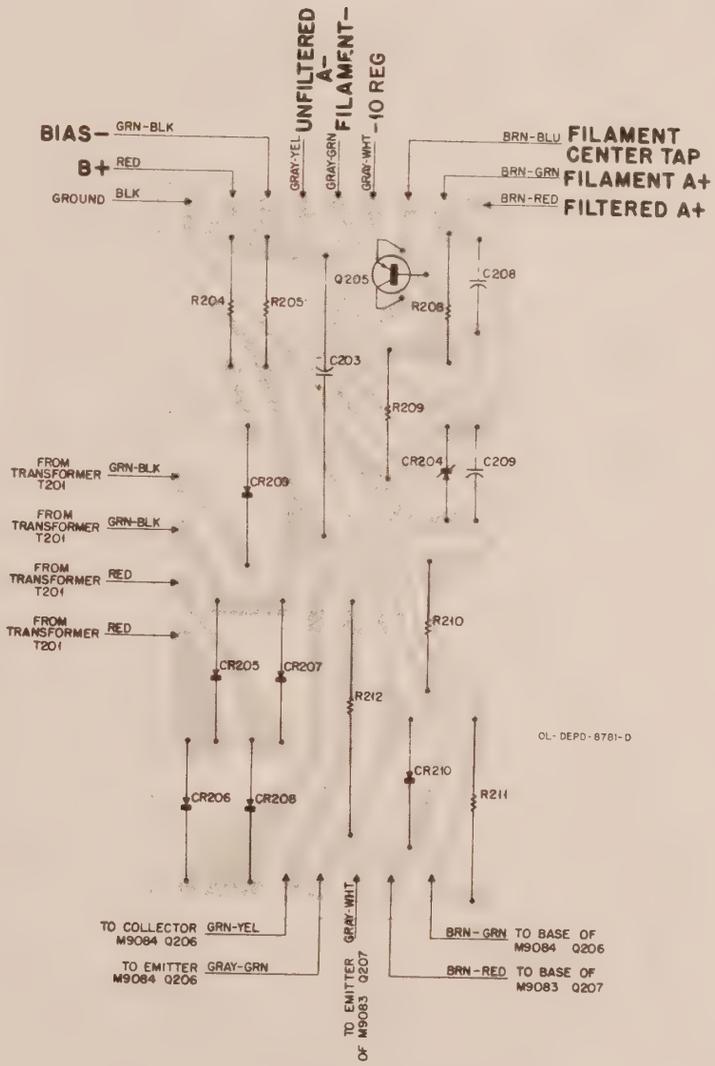
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uf ±10%; unl. stated
C102	8D82905G03	.047; 25 v
C103, 112	23K865136	15 ±20%; 25 v
C104	8K847099	0.1 uf ±20%; 150 v
C105	21C82187B20	.001; 100 v
C107	8D82905G23	.02; 100 v
C109	21K859942	220 uuf ±5%; 500 v
C111	21K863309	.0027 ±10%; 500 v
C113	21D82610C29	51 ±5%; N150
C114, 120, 121, 127, 128, 136	21D82428B02	.01 +70-30%; 100 v; X5U9
C115	8D82905G11	.22; 25 v
C116, 126	21C82187B17	820 uuf; 500 v
C117	21K840365	24 uuf ±5%; 500 v; NP0
C118, 119	21D82610C30	68 uuf ±5%; N330
C122	21D82610C28	130 uuf ±5%; N470
C123, 125	21D82133G01	10 uuf ±5%; 500 v; NP0
C124	21D82610C27	120 uuf ±5%; N470
C168 C393	21R125699	2.7 uuf ±0.25 uuf; 500 v; NP0 Used with Radio Common Carrier models only.
		SEMICONDUCTOR DEVICE, diode: SEE NOTE
CR102, 103	48C82392B03	silicon
CR104	48C82921G01	germanium
		COIL, RF:
L101	25D82113H02	choke; 1.0 h
L102	24D82480B02	choke; 16 uh
L103	24B83091A01	incl. 76B82572G03 CORE, tuning
L104	24B83092A01	incl. 76B82572G03 CORE, tuning
		TRANSISTOR: SEE NOTE
Q101, 102	48R869311	P-N-P; type M9311
Q103, 104	48R869081	P-N-P; type M9081
Q105	48R869082	P-N-P; type M9082
		RESISTOR, fixed: ±10%; 1/2 w; unl. stated
R101, 152	6R2085	39
R102	6R5683	27
R103, 153	6R5550	47
R104	6R6090	470
R105	6S5652	2.7K ±5%
R106	6S125A54	1.6K ±5%
R107, 115	6R6320	10K
R108	6R6291	560
R109	6S125A16	43 ±5%
R110	6S2003	3.3K ±5%
R111	6R6434	27K
R112, 124	6R6394	12K
R113	6R5591	18K
R114	6R6477	15K
R117	6R6040	680
R119	6R6449	82K
R120	18D82238D04	var.; 1K
R121	6R400076	39K
R122	6R6117	5.6K
R123	6R5577	2.7K
R125	6R6428	6.8K
R126	6R5581	3.3K
R127	6R6393	1.2K
R128, 131	6R6326	100
R129	6R6048	47K
R130	6R6432	270
R151	6R2039	68
R390	6R6270	220
	NON-REFERENCED ITEMS	
	26A82076C03	SHIELD, coil: used for L103, L104
	1V80728A84	CIRCUIT BOARD ASSY. (eyeleted)

NOTE:

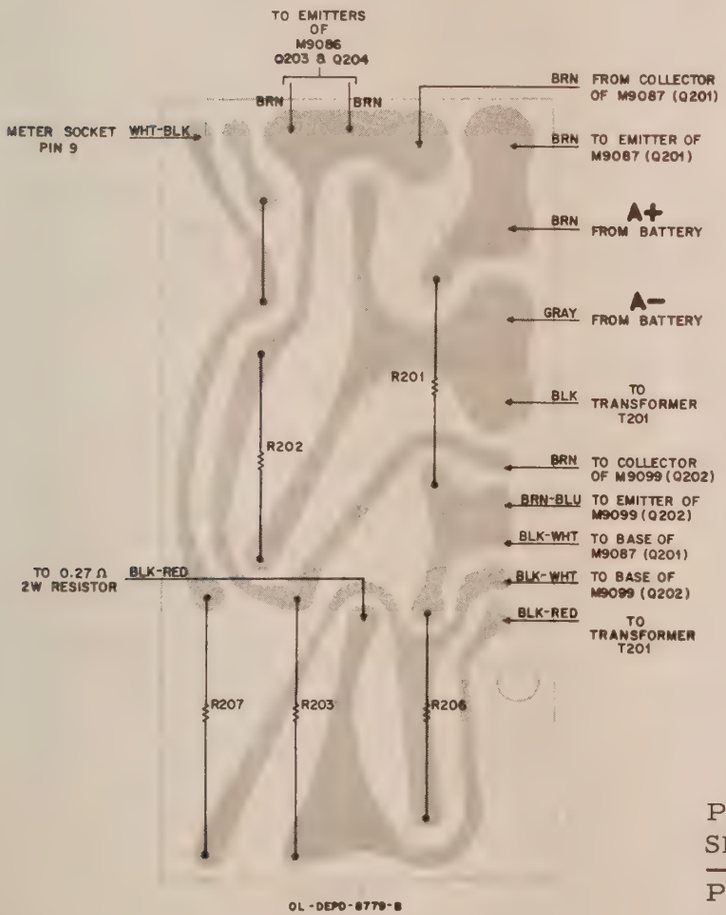
Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.



Power Regulator



Power Supply



PREVIOUS REVISIONS AND PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

Power Supply and Regulator Circuit Board Details
Model TPN6046A-2 used in 152-162 MC, 20 W, ±12 V DC
Motorola Car Telephone Radio Set
Motorola No. EPD-8782-K (SMR-868E)
7/9/71

REVISIONS

EPD-8782-K

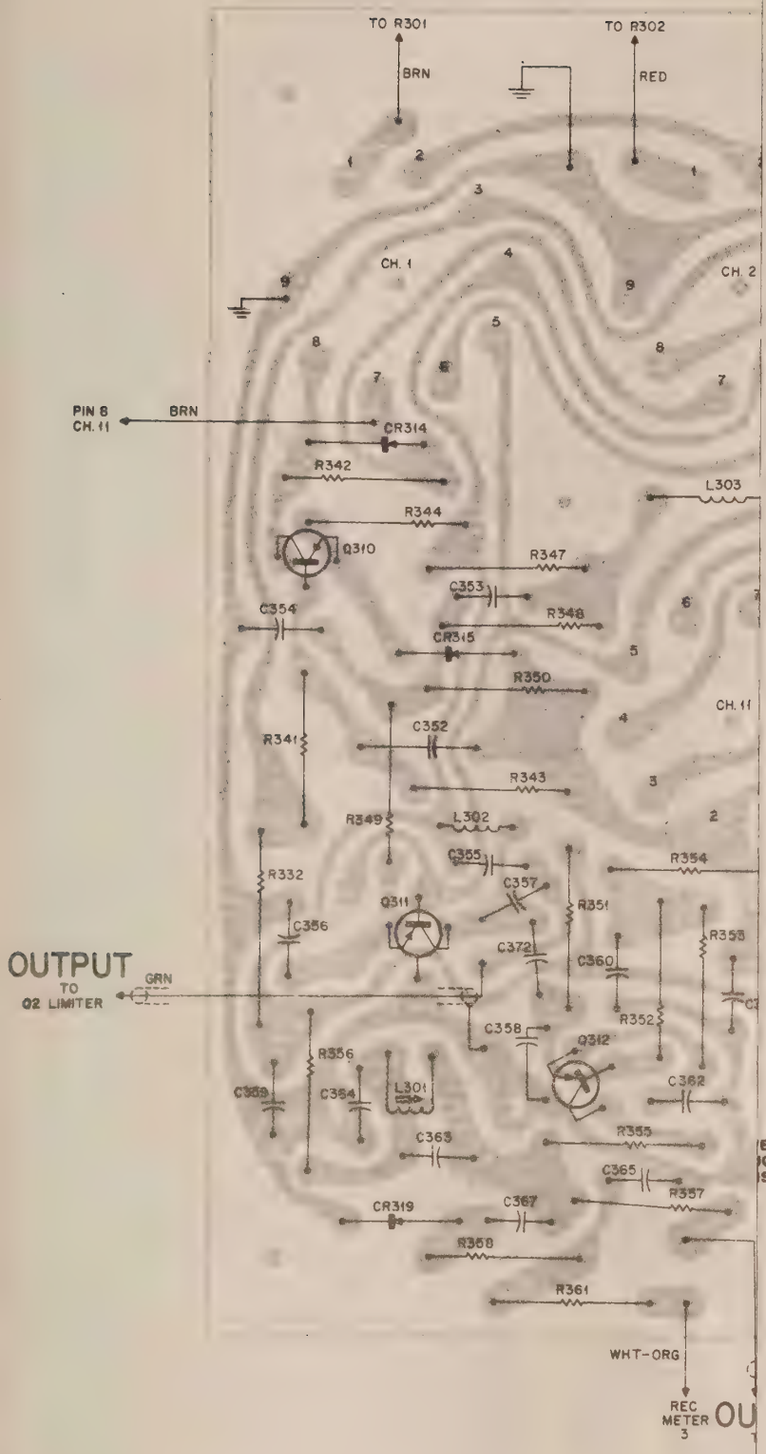
BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
TPN6046A		ADDED RF. Q205 TO TRANSISTOR	REGULATOR CIRCUIT BOARD
TPN6046A		ADDED 68P81020A75	DIAGRAM BOOKLET LIST
TPN6046A-1	Q205	WAS 48R134573	PARTS LIST
TPN6046A-1		ADD DIAGRAM BOOKLET 68P81022A65	
TPN6046A-1	CR203	WAS CR210	REGULATOR CIRCUIT BOARD
TPN6046A-1		TITLES ADDED TO CIRCUIT BOARD.	
TPN6046A-1		REFER TO 63E81022A67 FOR DETAIL OF CHANGES	PARTIAL SCHEMATIC DIAGRAM
TPN6046A-2	CR202	REMOVED 48C82392B03	UPPER RIGHT OF POWER SUPPLY CKT. BRD.
	CR205, 206, 207, 208	WERE 48D82723C05, TYPE SR335	LOWER LEFT OF POWER REGULATOR CKT. BRD.
	CR209	WAS 48D82723C01, TYPE SR331	UPPER LEFT OF POWER REGULATOR CKT. BRD.
	R202	WAS 6R3968	LEFT CENTER OF POWER SUPPLY CKT. BRD.
TPN6046A-3	CR211	DIODE ADDED	Q207 EMITTER
	CR204	WAS 48C82256C11	PARTS LIST
	R213	WAS 6R6408, 100 OHMS	Q207 BASE
	R209	WAS 6R5672, 180 OHMS	Q205 BASE
	R210	WAS 6R5673, 56 OHMS, 1/2 W	Q206 BASE
	R211	WAS 17C82036G04, 27 OHMS	
	Q205	WAS 48R869072, TYPE M9072	FIL. REG.

TPN6046A Power Supply & Regulator PL-1015-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed:
C203	23D82601A08	25 uf +150-10%; 50 v
C208, 209	21C82372C06	0.2 uf +80-20%; 25 v
		SEMICONDUCTOR DEVICE, diode: NOTE
CR204	48C82256C55	zener type; 9.4 v
CR205, 206, 207, 208	48C82466H16	silicon
CR209, 211	48C82466H12	silicon
CR210	48C82392B03	silicon
		TRANSISTOR, P-N-P: NOTE
Q201	48R869087	type M9087
Q202	48R869099	type M9099
Q203, 204	48R869086	type M9086
Q205	48R869641	type M9641
Q206	48R869083	type M9083
Q207	48R869084	type M9084
		RESISTOR, fixed: ±10%; unl. stated
R201	17C82036G03	2 ±5%; 2 w
R202	17C82036G10	180; 2 w
R203	17C82177B01	3; 5 w
R204	6R6038	1.5K; 1/2 w
R205	6R6040	680; 1/2 w
R206	17C82036G02	3.9 ±5%; 2 w
R207	17C82177B05	50; 5 w
R208	6R6408	100 ±5%; 1/2 w
R209	6R5645	150 ±5%; 1/2 W
R210	17C82036G04	27 ±5%; 2 W
R211	17C82036G08	10 ±5%; 2 W
R212	17C82177B04	5; 5 W
R213	6S410020	75 ±5%; 1/2 W
		TRANSFORMER, power:
T201	25D82064G01	pri. #1: YEL, BLU with BLK center tap; res. .019 ohms pri. #2: BLU-RED, YEL-RED with BLK-RED tap; res. .024 ohms sec. #1: RED, RED; res. 26 ohms sec. #2: GRN-BLK, GRN-BLK; res. 3.40 ohms
		SOCKET, transistor:
XQ201, 202, 206, 207	9D82673A01	2 contact
NON-REFERENCED ITEMS		
	15D82049G01	HOUSING, heat sink
	14K865854	INSULATOR, mica: used with Q202, Q206 and Q207
	14A851751	INSULATOR, mica: used with Q201, Q203 and Q204
	1V80729A73	CIRCUIT BOARD #1: (28 eyelets)
	1V80729A75	CIRCUIT BOARD #2: (54 eyelets)
	3A82227A01	SCREW, special: used with circuit boards #1 and #2
	55B82151G01	HANDLE
	41A82150G01	SPRING, handle: 2 used
	22A82011D02	PIN, handle: 2 used

NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.



PARTS LIST

TLN6620B Oscillator Switching Module Socket Board PL-1174-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uf; unl stated
C332, 337, 342, 353, 354, 356, 359, 360, 361, 362, 364, 365, 371	21C82428B58	.01 +80-20%; 500 v
C333, 338, 340, 341	23K865137	4.7 ±20%; 25 v
C334, 335, 352	8C82095G06	0.1 ±10%; 200 v
C336, 339	21D82428B27	.0047 ±10%; 100 v
C355	21K840812	200 uuf ±5%; 500 v
C357	21K859938	75 uuf ±5%; 500 v
C358	21K847091	80 uuf ±2%; 300 v
C363	21K873266	68 uuf ±2%; 500 v
C367	21K840847	5 uuf ±0.5 uuf; 500 v; NP0
C372	21K850118	100 uuf ±5%; 500 v
C394		used with radio common carrier modes only
		SEMICONDUCTOR DEVICE, diode: NOTE I
CR301 thru 311, 313, 315	48C82392B03	silicon
CR314, 316, 317, 319	48C82921G01	germanium
		COIL, RF:
L301	24V80902A07	incl. 1K867235 CORE, tuning
L302	24D82835G04	1.5 uh; coded BRN-GRN-GOLD
L303	24C82835G13	choke; 0.82 uh
		TRANSISTOR: NOTE I
Q301	48R869570	N-P-N; type M9570
Q302, 303, 304, 305, 306, 310	48R869105 or 48R134595	P-N-P; type M9105 or P-N-P; type M4595
Q311	48R869403	P-N-P; type M9403
Q312	48R869081	P-N-P; type M9081
		RESISTOR, fixed: ±5%: 1/2 w; unl stated
R301 thru 311, 324	6R3924	4.7K
R312, 318	6R2028	2.2K
R313	6S6410	33k ±10%
R315	6R400058	560
R316, 320, 328, 331, 344	6R2003	3.3K
R317, 319	6R488095	18K
R321	6R6031	100K ±10%
R322	6R6407	220K ±10%
R323	6R6320	10K ±10%
R325	6D82672B07	47.5 ±1%
R326	6R120638	330
R327	6R5556	10K
R329, 330	6R400076	39K
R332	6D82672B06	4220 ±1%
R341	6R2024	3.9K
R342, 345, 346	6R5652	2.7K
R343	6R400459	1.5K
R347, 349	6R6269	820 ±10%
R348, 357	6R6090	470 ±10%
R350, 354, 356	6R6373	150 ±10%
R351	6R6428	6.8K ±10%
R352	6R5581	3.3K ±10%
R353	6R6069	2.2K ±10%
R355	6R6432	270 ±10%
R358	6R6394	12K ±10%
R360	6R3940	5.6K
R361	6R6117	5.6K ±10%
		THERMISTOR:
RT301	6C82769A07	5020 ohms at 25°C

NON-REFERENCED ITEMS		
	1V80737A57	CIRCUIT BOARD ASSY. (eyeleted)
	9C858152	SOCKET, tube: 9 contact; 11 used
	26A82076C03	SHIELD, coil: used with L301

NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.

REVISIONS

EPD-8782-K

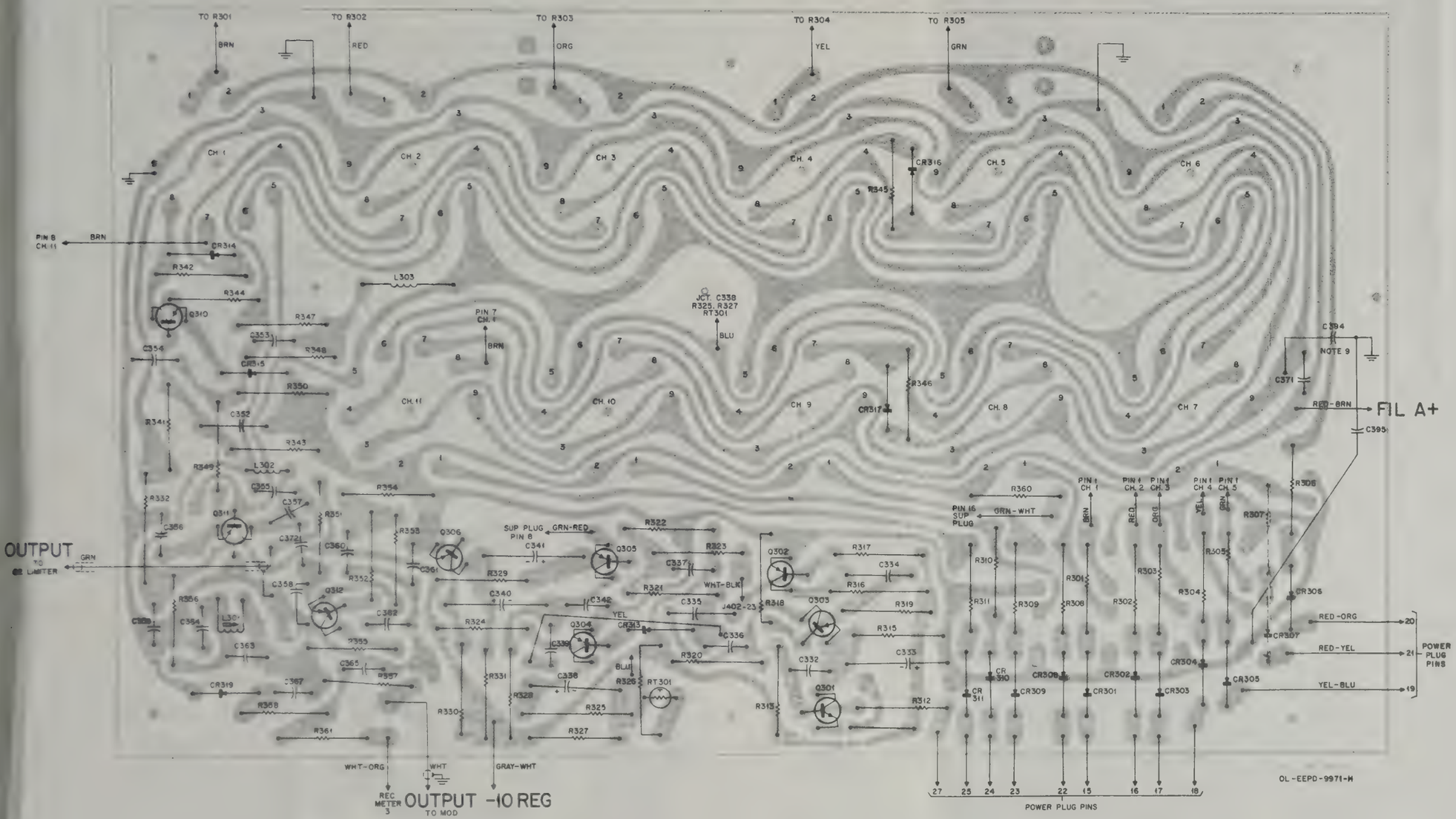
BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
TPN6046A		ADDED RF, Q205 TO TRANSISTOR	REGULATOR CIRCUIT BOARD
TPN6046A		ADDED 68P81020A75	DIAGRAM BOOKLET LIST
TPN6046A-1	Q205	WAS 48R134573	PARTS LIST
TPN6046A-1		ADD DIAGRAM BOOKLET 68P81022A65	
TPN6046A-1	CR203	WAS CR210	REGULATOR CIRCUIT BOARD
TPN6046A-1		TITLES ADDED TO CIRCUIT BOARD.	
TPN6046A-1		REFER TO 63E81022A67 FOR DETAIL OF CHANGES	PARTIAL SCHEMATIC DIAGRAM
TPN6046A-2	CR202	REMOVED 48C82392B03	UPPER RIGHT OF POWER SUPPLY CKT. BRD.
	CR205, 206, 207, 208	WERE 48D82723C05, TYPE SR335	LOWER LEFT OF POWER REGULATOR CKT. BRD.
	CR209	WAS 48D82723C01, TYPE SR331	UPPER LEFT OF POWER REGULATOR CKT. BRD.
	R202	WAS 6R3968	LEFT CENTER OF POWER SUPPLY CKT. BRD.
TPN6046A-3	CR211	DIODE ADDED	Q207 EMITTER
	CR204	WAS 48C82256C11	PARTS LIST
	R213	WAS 6R6408, 100 OHMS	Q207 BASE
	R209	WAS 6R5672, 180 OHMS	Q205 BASE
	R210	WAS 6R5673, 56 OHMS, 1/2 W	Q206 BASE
	R211	WAS 17C82036G04, 27 OHMS	
	Q205	WAS 48R869072, TYPE M9072	FIL. REG.

TPN6046A Power Supply & Regulator PL-1015-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed:
C203	23D82601A08	25 uf +150-10%; 50 v
C208, 209	21C82372C06	0.2 uf +80-20%; 25 v
		SEMICONDUCTOR DEVICE, diode: NOTE
CR204	48C82256C55	zener type; 9.4 v
CR205, 206, 207, 208	48C82466H16	silicon
CR209, 211	48C82466H12	silicon
CR210	48C82392B03	silicon
		TRANSISTOR, P-N-P: NOTE
Q201	48R869087	type M9087
Q202	48R869099	type M9099
Q203, 204	48R869086	type M9086
Q205	48R869641	type M9641
Q206	48R869083	type M9083
Q207	48R869084	type M9084
		RESISTOR, fixed: ±10%; unl. stated
R201	17C82036G03	2 ±5%; 2 w
R202	17C82036G10	180; 2 w
R203	17C82177B01	3; 5 w
R204	6R6038	1.5K; 1/2 w
R205	6R6040	680; 1/2 w
R206	17C82036G02	3.9 ±5%; 2 w
R207	17C82177B05	50; 5 w
R208	6R6408	100 ±5%; 1/2 w
R209	6R5645	150 ±5%; 1/2 W
R210	17C82036G04	27 ±5%; 2 W
R211	17C82036G08	10 ±5%; 2 W
R212	17C82177B04	5; 5 W
R213	6S410020	75 ±5%; 1/2 W
		TRANSFORMER, power:
T201	25D82064G01	pri. #1: YEL, BLU with BLK center tap; res. .019 ohms pri. #2: BLU-RED, YEL-RED with BLK-RED tap; res. .024 ohms sec. #1: RED, RED; res. 26 ohms sec. #2: GRN-BLK, GRN-BLK; res. 3.40 ohms
		SOCKET, transistor:
XQ201, 202, 206, 207	9D82673A01	2 contact
	NON-REFERENCED ITEMS	
	15D82049G01	HOUSING, heat sink
	14K865854	INSULATOR, mica: used with Q202, Q206 and Q207
	14A851751	INSULATOR, mica: used with Q201, Q203 and Q204
	1V80729A73	CIRCUIT BOARD #1: (28 eyelets)
	1V80729A75	CIRCUIT BOARD #2: (54 eyelets)
	3A82227A01	SCREW, special: used with circuit boards #1 and #2
	55B82151G01	HANDLE
	41A82150G01	SPRING, handle: 2 used
	22A82011D02	PIN, handle: 2 used

NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.



NOTE:
7. DUMMY ELEMENT MUST BE USED IN PLACE OF CHANNEL ELEMENT WHEN OPERATION ON THAT CHANNEL IS NOT DESIRED.
9. CAPACITOR C394 IS USED WITH RADIO COMMON CARRIER MODELS ONLY

PARTS LIST

TLN6620B Oscillator Switching Module Socket Board PL-1174-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uf; unl stated
C332, 337, 342, 353, 354, 356, 359, 360, 361, 362, 364, 365, 371	21C82428B58	.01 +80-20%; 500 v
C333, 338, 340, 341	23K865137	4.7 ±20%; 25 v
C334, 335, 352	8C82095G06	0.1 ±10%; 200 v
C336, 339	21D82428B27	.0047 ±10%; 100 v
C355	21K840812	200 uuf ±5%; 500 v
C357	21K859938	75 uuf ±5%; 500 v
C358	21K847091	80 uuf ±2%; 300 v
C363	21K873266	68 uuf ±2%; 500 v
C367	21K840847	5 uuf ±0.5 uuf; 500 v; NP0
C372	21K850118	100 uuf ±5%; 500 v
C394		used with radio common carrier modes only
		SEMICONDUCTOR DEVICE, diode: NOTE 1
CR301 thru 311, 313, 315	48C82392B03	silicon
CR314, 316, 317, 319	48C82921G01	germanium
		COIL, RF:
L301	24V80902A07	incl. 1K867235 CORE, tuning
L302	24D82835G04	1.5 uh; coded BRN-GRN-GOLD
L303	24C82835G13	choke; 0.82 uh
		TRANSISTOR: NOTE 1
Q301	48R869570	N-P-N; type M9570
Q302, 303, 304, 305, 306, 310	48R869105 or48R134595	P-N-P; type M9105 P-N-P; type M4595
Q311	48R869403	P-N-P; type M9403
Q312	48R869081	P-N-P; type M9081
		RESISTOR, fixed: ±5%: 1/2 w; unl stated
R301 thru 311, 324	6R3924	4.7K
R312, 318	6R2028	2.2K
R313	6S6410	33k ±10%
R315	6R400058	560
R316, 320, 328, 331, 344	6R2003	3.3K
R317, 319	6R488095	18K
R321	6R6031	100K ±10%
R322	6R6407	220K ±10%
R323	6R6320	10K ±10%
R325	6D82672B07	47.5 ±1%
R326	6R120638	330
R327	6R5556	10K
R329, 330	6R400076	39K
R332	6D82672B06	4220 ±1%
R341	6R2024	3.9K
R342, 345, 346	6R5652	2.7K
R343	6R400459	1.5K
R347, 349	6R6269	820 ±10%
R348, 357	6R6090	470 ±10%
R350, 354, 356	6R6373	150 ±10%
R351	6R6428	6.8K ±10%
R352	6R5581	3.3K ±10%
R353	6R6069	2.2K ±10%
R355	6R6432	270 ±10%
R358	6R6394	12K ±10%
R360	6R3940	5.6K
R361	6R6117	5.6K ±10%
		THERMISTOR:
RT301	6C82769A07	5020 ohms at 25°C
	NON-REFERENCED ITEMS	
	1V80737A57	CIRCUIT BOARD ASSY. (eyeleted)
	9C858152	SOCKET, tube: 9 contact; 11, used
	26A82076C03	SHIELD, coil: used with L301

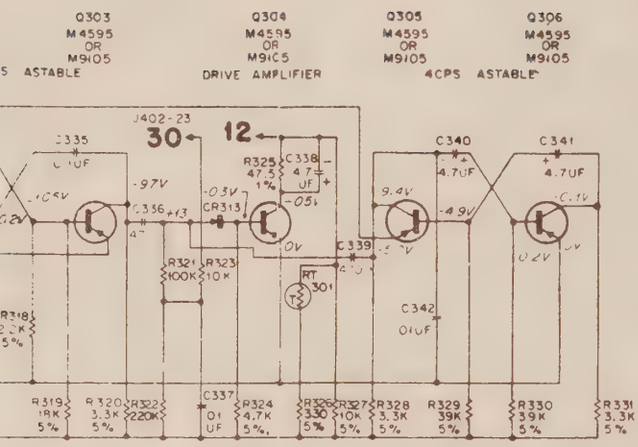
NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.

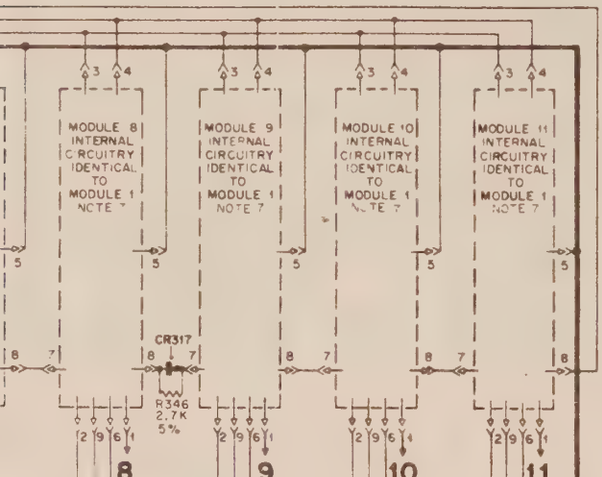
REVISIONS

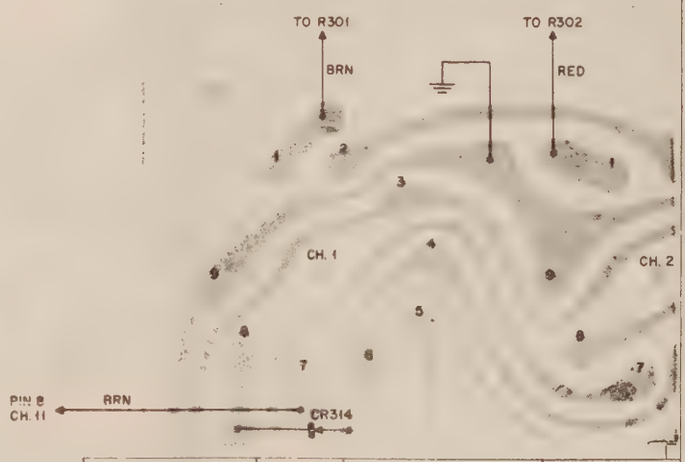
EPD-9972-J

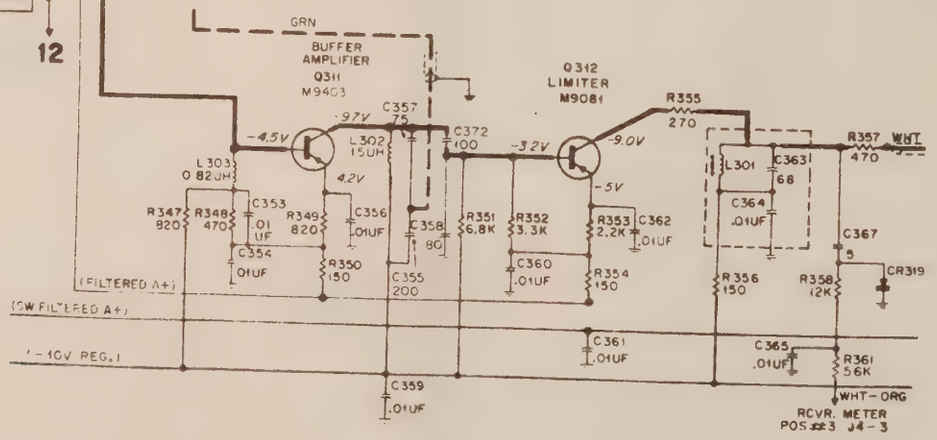
BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
TLN6620B		BOARD OUTLINE ADDED	
		ADDED 68P81022A65	DIAGRAM BOOKLET LIST
TLN6620B		WIRE LEAD J102-9 REPLACED BY WIRE LEAD J402-23	UPPER RIGHT OF Q303
TLN6620B-1	Q311	WAS 48R869133 TYPE M9133	PARTS LIST
TLN6620B-2	C321 THRU 331	REMOVED 21C82372C04 .05 uf +80-20%; 25 V CIRCUIT WAS AS SHOWN BELOW	LOWER RT. OF CKT. BD.
	C332, 337, 342, 353, 354, 356, 359, 360, 361, 362, 264, 365, 371	WERE 21C82428B05 .01 uf +70-30%; 100 V	PARTS LIST
TLN6620B-2		ADDED CHANNEL ELEMENT CIRCUIT	PARTIAL SCHEMATIC
TLN6620B-2			CIRCUIT WAS AS SHOWN BELOW
TLN6620B-2	C341	ADDED .01 uf	CENTER RT OF CKT BD

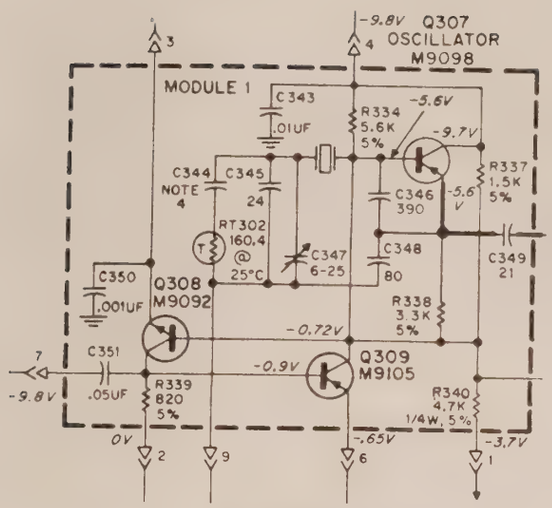


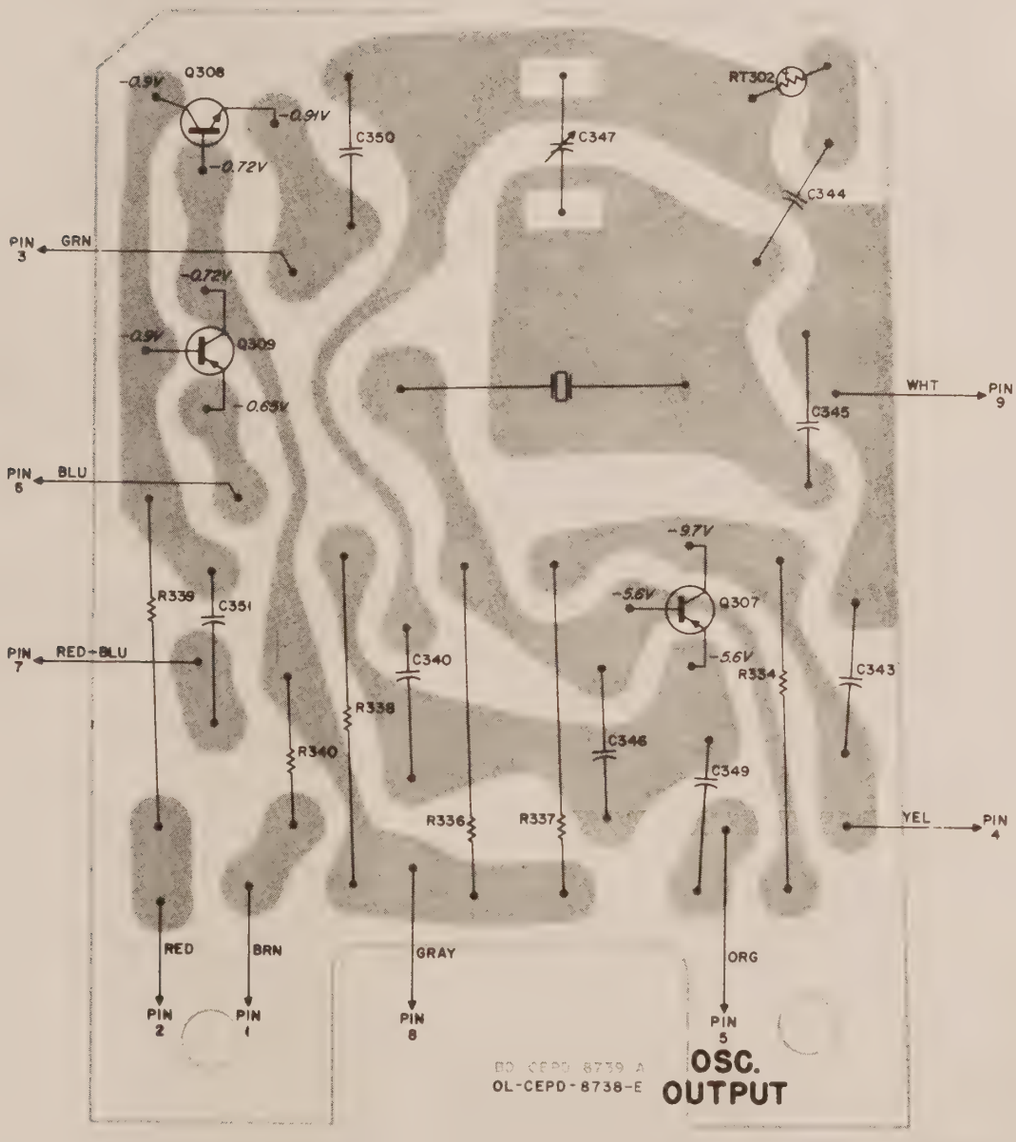












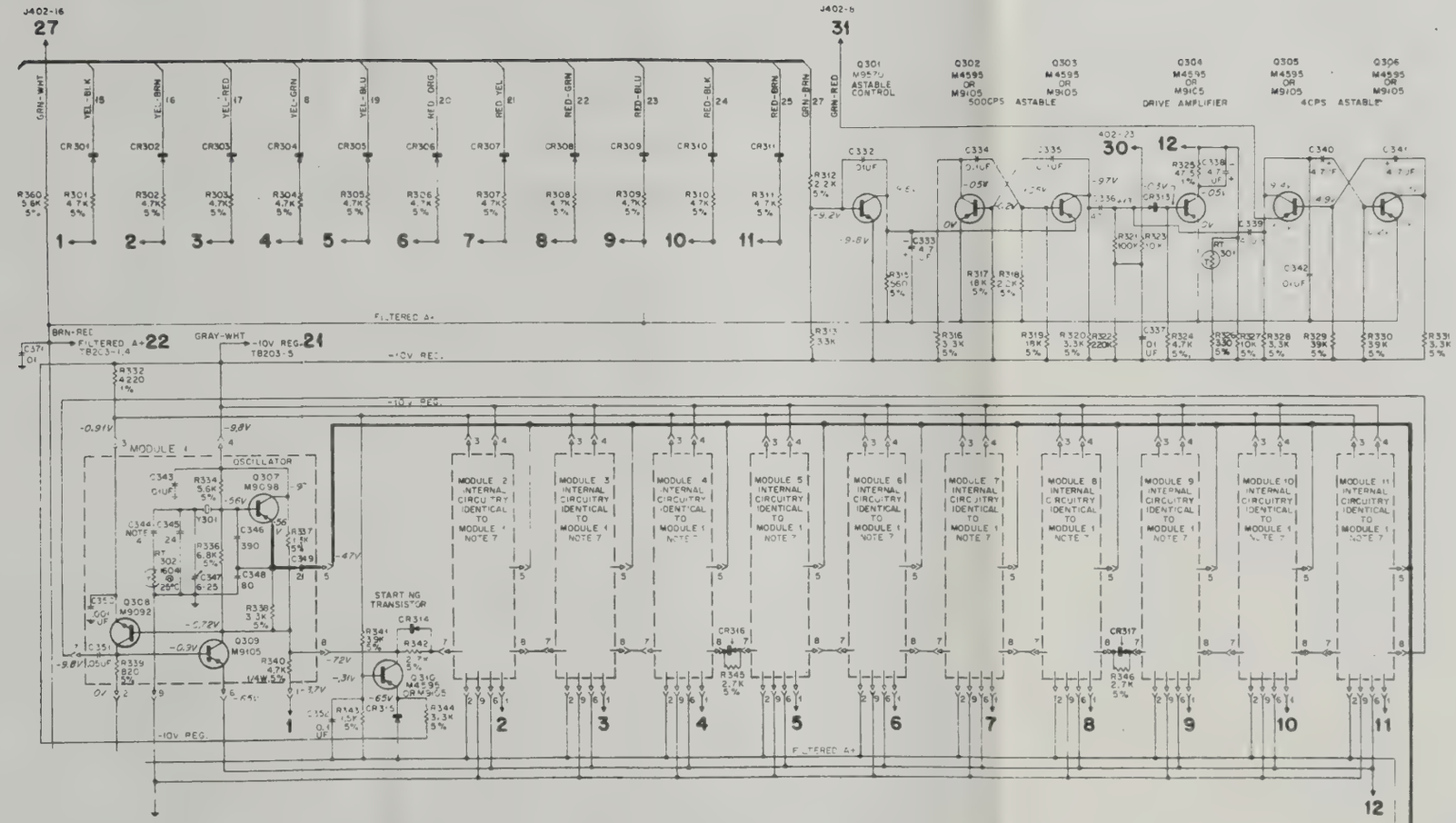
PREVIOUS REVISIONS AND PARTS LIST
SHOWN ON BACK OF THIS DIAGRAM

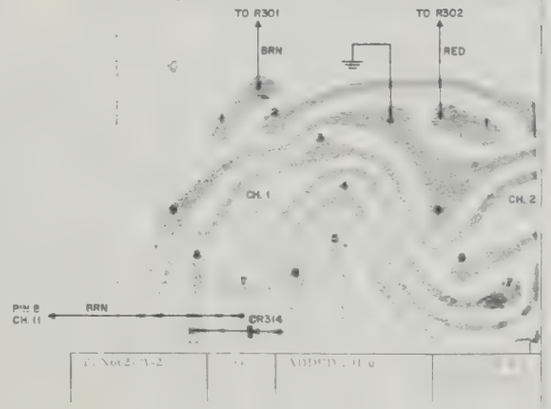
152-162 MC Car Telephone
Radio Set
Channel Element Oscillator
Circuit Board Detail
Model TLN6610A-2
Motorola No. EPD-8737-K (SMR-707A)
4/23/70.

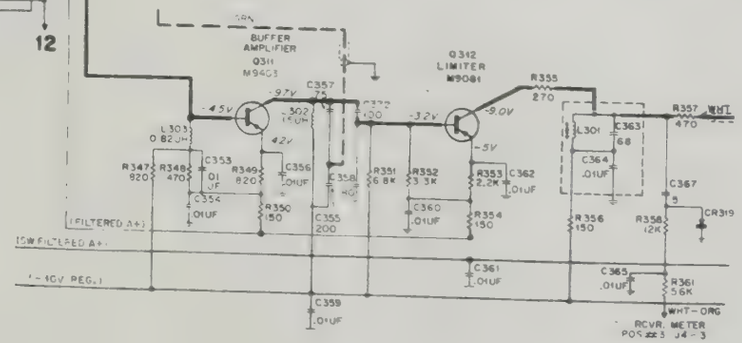
REVISIONS

BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
[illegible]		[illegible]	
		[illegible]	BOOKLET
[illegible]		WIRE LEAD J10[illegible] REPLACED BY WIRE LEAD J402-23	UPPER RIGHT OF Q303
[illegible]		WAS 48R86[illegible]133 TYPE M9133	PARTS LIST
[illegible]	[illegible]	REMOVED 21C82372C04 .05 uf -80+20%, 25 V CIRCUIT WAS [illegible] SHOWN BELOW	LOWER RT. OF CKT [illegible]
		WERE 21C8[illegible] .01 uf -70-	[illegible]



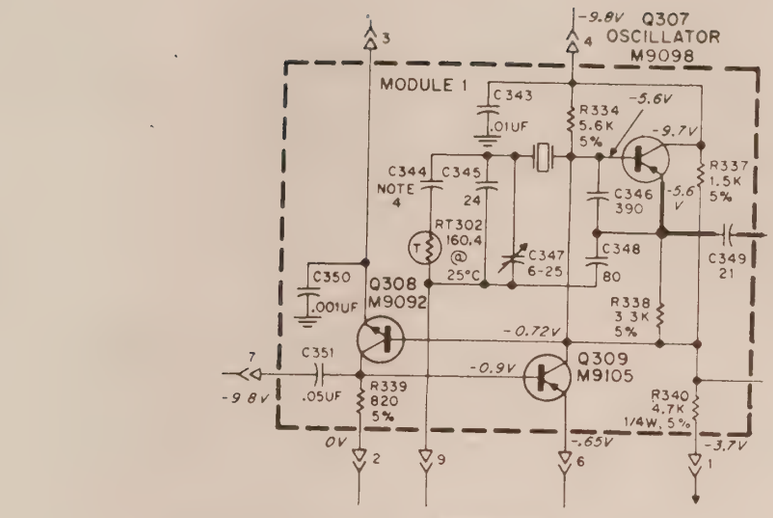


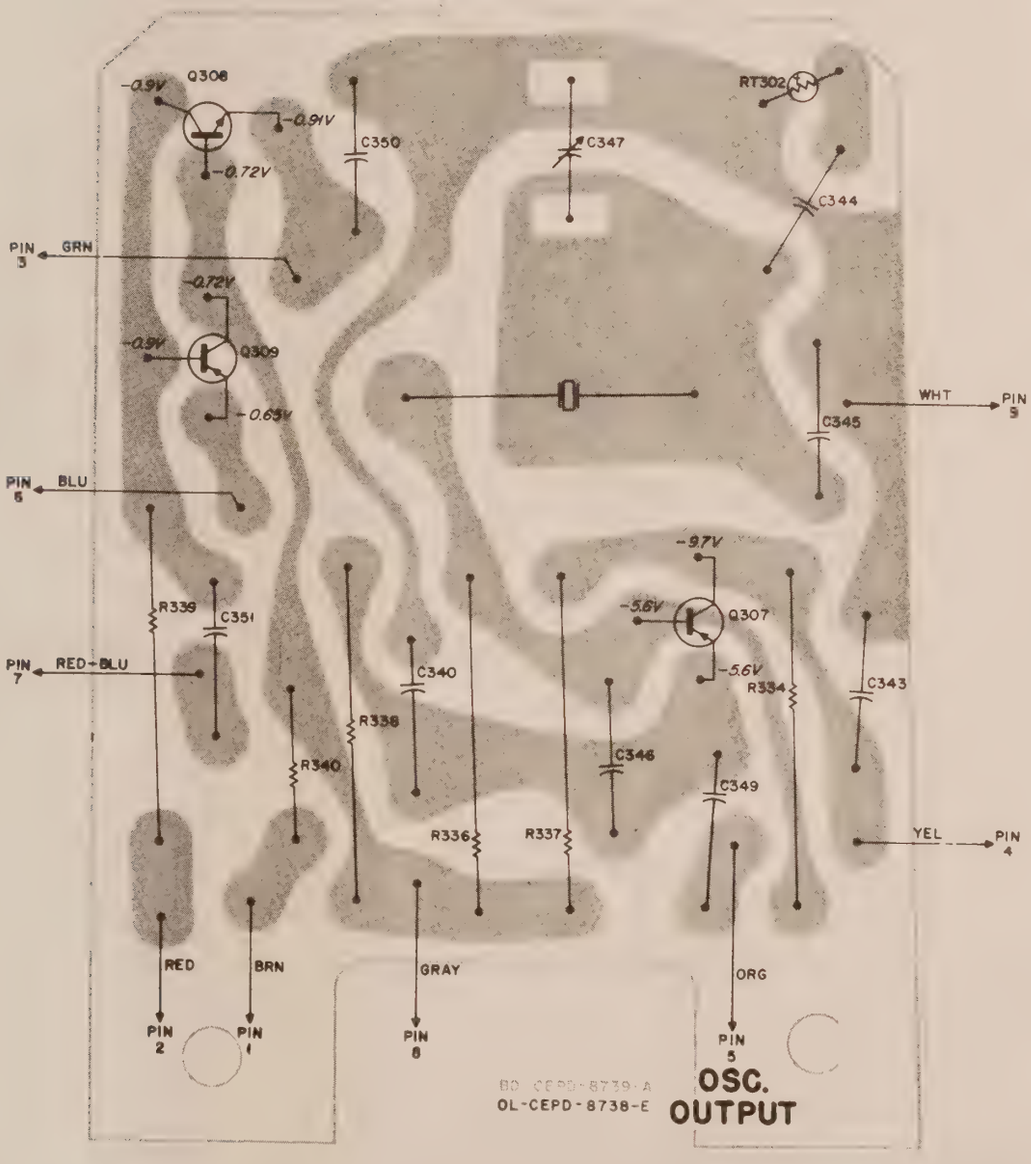




PREVIOUS REVISIONS AND PARTS LIST
SHOWN ON BACK OF THIS DIAGRAM

TLN6620B-3 Oscillator Module
Socket Board Detail
Motorola No. EPD-9972-J (SMR-1173F)
1/14/72-





PREVIOUS REVISIONS AND PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

152-162 MC Car Telephone
Radio Set
Channel Element Oscillator
Circuit Board Detail
Model TLN6610A-2
Motorola No. EPD-8737-K (SMR-707A)
4/23/70.

REVISIONS

EPD-8737-K

BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
TLN6610A	C345	WAS 21D82133G08, 20 uuf	RIGHT CENTER OF BD.
	R337	WAS 6R5652, 2.7K	BOTTOM OF BD.
	R338	WAS 6R6411, 1K	
	R335	REMOVED 6K129805, 1K OHMS. WAS CONNECTED BETWEEN V301 and RT302	TOP OF BD.
TLN6610A-1 TLN6610A-2	C343	WAS 21D82428B05, .01 uf; 100 V	PARTS LIST

PARTS LIST

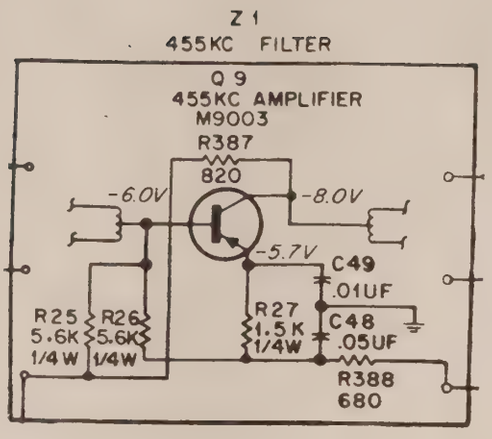
TLN6610A Oscillator Switching Module — PL-980-A

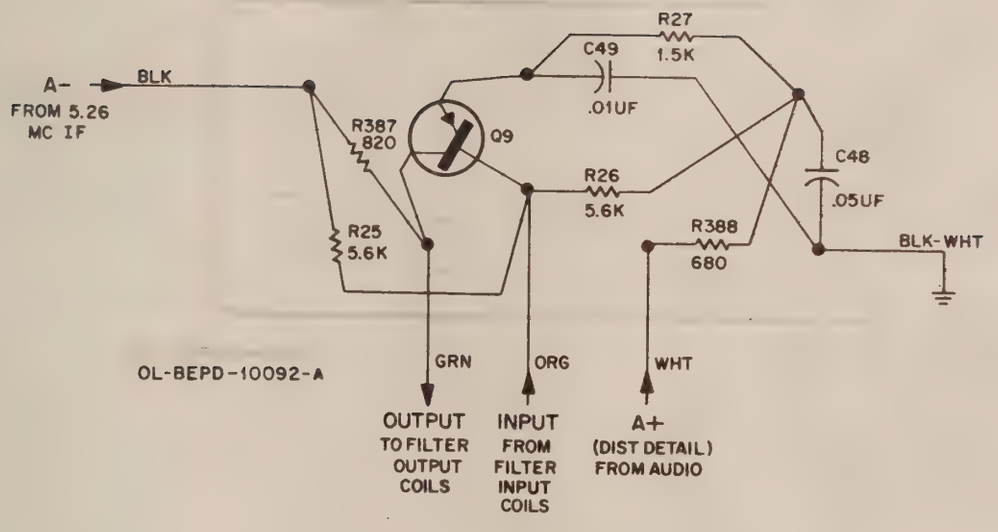
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uuf: unl stated
C343	21D82428B59	.01 uF +70-30%; 200 V
C344	21D82989E01	5.6 ±0.1; NP0 (BLU) — factory selected
	or21D82989E02	6.2 ±0.1; NP0 (RED) — factory selected
	or21D82989E03	6.8 ±0.1; NP0 (ORG) — factory selected
	or21D82989E04	7.5 ±0.1; NP0 (YEL) — factory selected
	or21D82989E08	7.8 ±0.1; NP0 (BLK) — factory selected
	or21D82989E05	8.2 ±0.1; NP0 (GRN) — factory selected
	or21D82989E09	8.6 ±0.1; NP0 (BRN) — factory selected
	or21D82989E06	9.1 ±0.1; NP0 (VIO) — factory selected
	or21D82989E07	10 ±0.1; NP0 (WHT) — factory selected
C345	21D82355B13	24 ±5%; N750
	or21D82355B03	24 ±5%; N330
	or21K840365	24 ±5%; NP0
C346	21K848977	390 ±3%; 500 V
C347	20C82686B02	var.; 6-25; 350 V; NP0
C348	21K847091	80 ±2%; 300 V
C349	21K848272	21 ±5%; 300 V
C350	21C82187B20	.001 uF ±10%; 100 V
C351	21C82372C04	.05 uF +80-20%; 25 V
		TRANSISTOR: (SEE NOTE)
Q307	48R869098	P-N-P; type M9098
Q308	48R869092	N-P-N; type M9092
Q309	48R869105	P-N-P; type M9105
		RESISTOR, fixed: ±5%; 1/2 W; unl stated
R334	6R3940	5.6K
R336	6R2001	6.8K
R337	6R400459	1.5K
R338	6R2003	3.3K
R339	6R119172	820
R340	6K129669	4.7K; 1/4 W
		THERMISTOR:
RT302	6C82990E01	160.4 ±5%; @ 25°C
		NON-REFERENCED ITEMS
		CHANNEL ELEMENT: incl. TLN6610A switching module and crystal unit
		(Code) — Xmit. (in MC) — Rcvr. (in MC)
	TLD1011A	JK — 158.04 — 152.78
	TLD1012A	JL — 157.77 — 152.51
	TLD1013A	JP — 157.83 — 152.57
	TLD1014A	JR — 158.07 — 152.81
	TLD1015A	JS — 157.95 — 152.69
	TLD1016A	YJ — 157.89 — 152.63
	TLD1017A	YK — 157.92 — 152.66
	TLD1018A	YL — 157.80 — 152.54
	TLD1019A	YP — 157.86 — 152.60
	TLD1020A	YR — 158.01 — 152.75
	TLD1021A	YS — 157.98 — 152.72
	TLD1022A	1 — 158.49 — 152.03
	TLD1023A	3 — 158.52 — 152.06
	TLD1024A	5 — 158.55 — 152.09
	TLD1025A	7 — 158.58 — 152.12
	TLD1026A	9 — 158.61 — 152.15
	TLD1027A	11 — 158.64 — 152.18
	TLD1028A	13 — 158.67 — 152.21

NOTE:

Transistors must be ordered by Motorola Part number only for optimum performance.

USED IN CAR TELEPHONE
DIAGRAM BOOKLETS
68P81020A75
68P81022A65





PREVIOUS REVISIONS AND PARTS LIST
SHOWN ON BACK OF THIS DIAGRAM

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455 KC Filter Amplifier Circuit Board Detail
p/o Model TFN6018AS Filter
Used in 152-162 MC, 20 W, ±12 V DC
Motorola Car Telephone Receiver
Motorola No. EPD-10093-D (SMR-991A)
4/23/71.

REVISIONS

EPD-10093-D

BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
TFN6018AS	C49	WAS 8D82905G01 .01 uF ±10%; 100 V	PARTS LIST

PARTS LIST

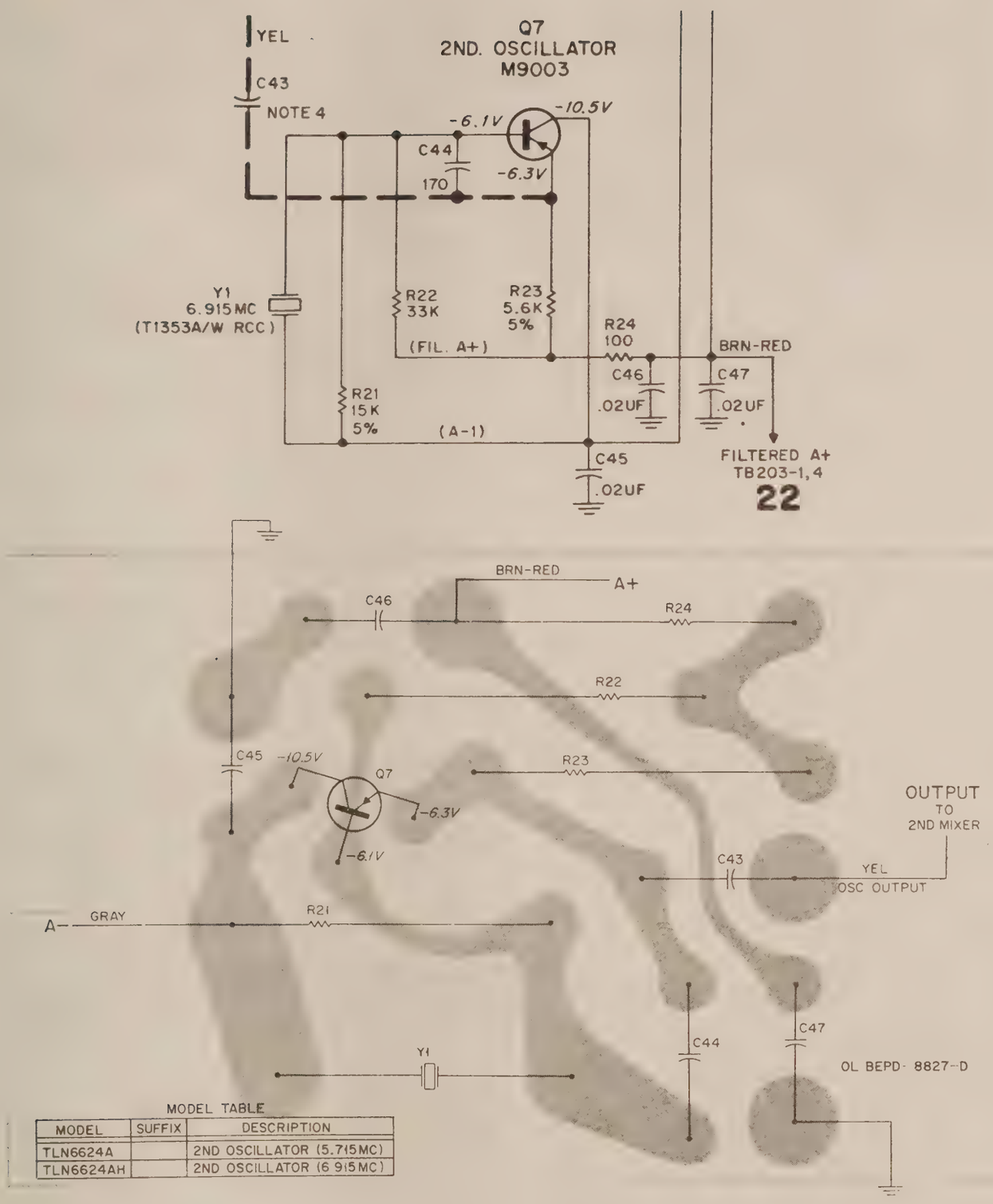
IF Filter

PL-1175-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
Z1	TFN6018AS	FILTER, IF: bandpass; 30 kHz; incl 1V80740A34, 455 kHz Filter Amplifier Board Assy.
1V80740A34 455 kHz Filter Amplifier Board		
		CAPACITOR, fixed:
C48	21C82372C07	.05 uF +80-20%; 25 V
C49	8D83514E05	.01 uF ±10%; 50 V
		TRANSISTOR: (SEE NOTE)
Q9	48R869003	P-N-P; type M9003
		RESISTOR, fixed: ±10%; 1/4 W
R25, 26	6S129433	5.6k
R27	6S127803	1.5k
R387	6S129432	820
R388	6S128599	680
NON-REFERENCED ITEM		
	1V80735A13	CIRCUIT BOARD ASSY. (eyelet)

NOTE:

Replacement transistors must be ordered by Motorola part number only for optimum performance.



MODEL TABLE

MODEL	SUFFIX	DESCRIPTION
TLN6624A		2ND OSCILLATOR (5.715MC)
TLN6624AH		2ND OSCILLATOR (6.915MC)

PREVIOUS REVISIONS SHOWN
ON BACK OF THIS DIAGRAM

152-162 MC Car Telephone
Radio Set
2nd Oscillator Circuit Board Detail
Used in 152-162 MC, 20 W, ±12 V DC
Motorola Car Telephone Receiver
Motorola No. EPD-8828-H (MR-2356A)
6/7/68

REVISIONS

DIAG. ISSUE	BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
A	TLN6624A		ENLARGED HOLES IN CIRCUIT BOARD PLATING	
B	TLN6624A		ADDED TRANSISTOR VOLTAGE INFORMATION	Q7
C	TLN6624A		ADDED 68P81020A75	DIAGRAM BOOKLET LIST
D	TLN6624A		ADDED 68P81022A65	DIAGRAM BOOKLET LIST
E	TLN6624A		ADDED 68P81028A65	DIAGRAM BOOKLET LIST
F	TLN6624A-1	C45, 46, 47	WERE 21D82428B18, .02 uf +60-40%; 100 V	PARTS LIST
G	TLN6624AH		ADDED	PARTS LIST
H	TLN6624AH-1	C43	WAS 21K87206 30 uuf FOR TLN6624AH	PARTS LIST

PARTS LIST

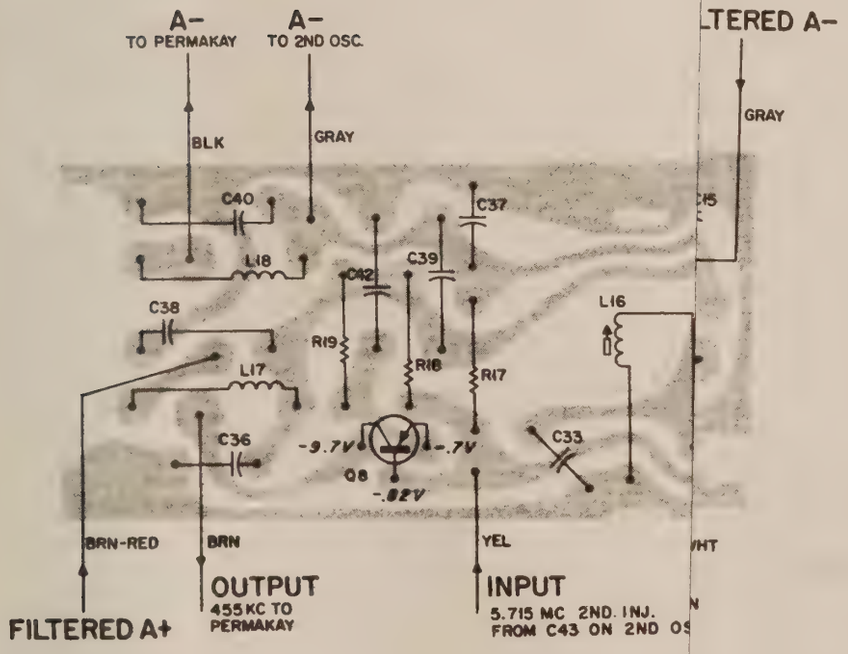
TLN6624A 2nd Oscillator (5.715 MC)
TLN6624AH 2nd Oscillator (6.915 MC) EPD-8828-H

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed:
C43	21K872060 or 21D82355B24	30 uuf ±5%; 1500 v (TLN6624A) 24 uuf ±5%; 500 v (TLN6624AH)
C44	21K865441	170 uuf ±3%; 500 v
C45, 45, 47	21D82428B26	.02 uf +80-20%; 200 v
		TRANSISTOR, P-N-P: NOTE I
Q7	48R869003	type M9003
		RESISTOR, fixed: ±10%; 1/2 w; unl. stated
R21	6S5726	15K ±5%
R22	6S6410	33K
R23	6S3940	5.6K ±5%
R24	6S6326	100
		CRYSTAL UNIT, quartz: NOTE II
Y1	G10 or AH	5.715 mc (TLN6624A) 6.915 mc (TLN6624AH)
NON-REFERENCED ITEMS		
	1V80728A44	CIRCUIT BOARD ASSY. (eyeleted)

NOTES:

I. Replacement transistors must be ordered by Motorola part number only for optimum performance.

II. Crystals are part of the Radio Set Model only. When ordering crystal units specify car. freq(s), crystal freq(s), crystal type number.



OUS REVISIONS AND PARTS LIST
ON BACK OF THIS DIAGRAM

C IF Circuit Board Detail
TLN6621B-5 used in
MC, 20 W, ±12 V DC
la Car Telephone Receiver
la No. EPD-10088-K (SMR-1112G)

REVISIONS

DIAG. ISSUE	BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
A	TLN6624A		ENLARGED HOLES IN CIRCUIT BOARD PLATING	
B	TLN6624A		ADDED TRANSISTOR VOLTAGE INFORMATION	Q7
C	TLN6624A		ADDED 68P81020A75	DIAGRAM BOOKLET LIST
D	TLN6624A		ADDED 68P81022A65	DIAGRAM BOOKLET LIST
E	TLN6624A		ADDED 68P81028A65	DIAGRAM BOOKLET LIST
F	TLN6624A-1	C45, 46, 47	WERE 21D82428B18, .02 uf +60-40%; 100 V	PARTS LIST
G	TLN6624AH		ADDED	PARTS LIST
H	TLN6624AH-1	C43	WAS 21K87206 30 uuf FOR TLN6624AH	PARTS LIST

PARTS LIST

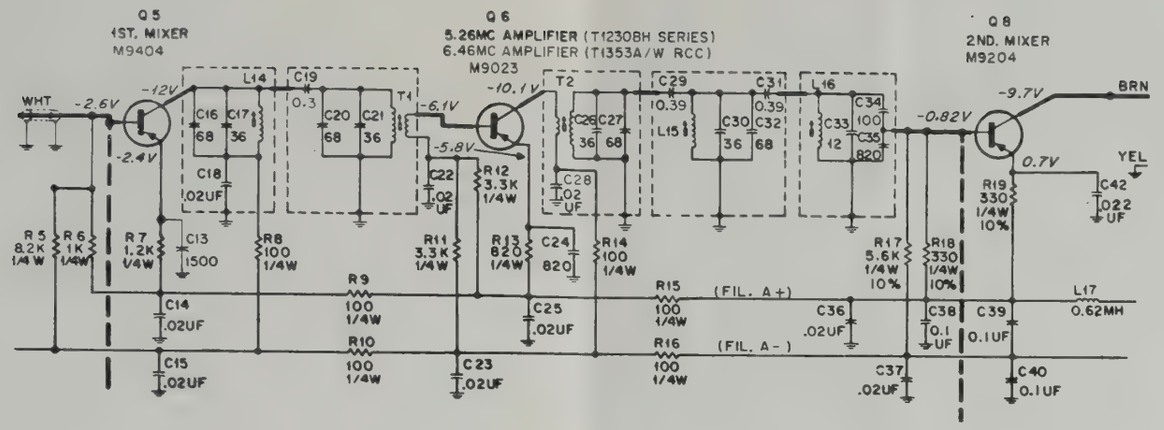
TLN6624A 2nd Oscillator (5.715 MC)
TLN6624AH 2nd Oscillator (6.915 MC) EPD-8828-H

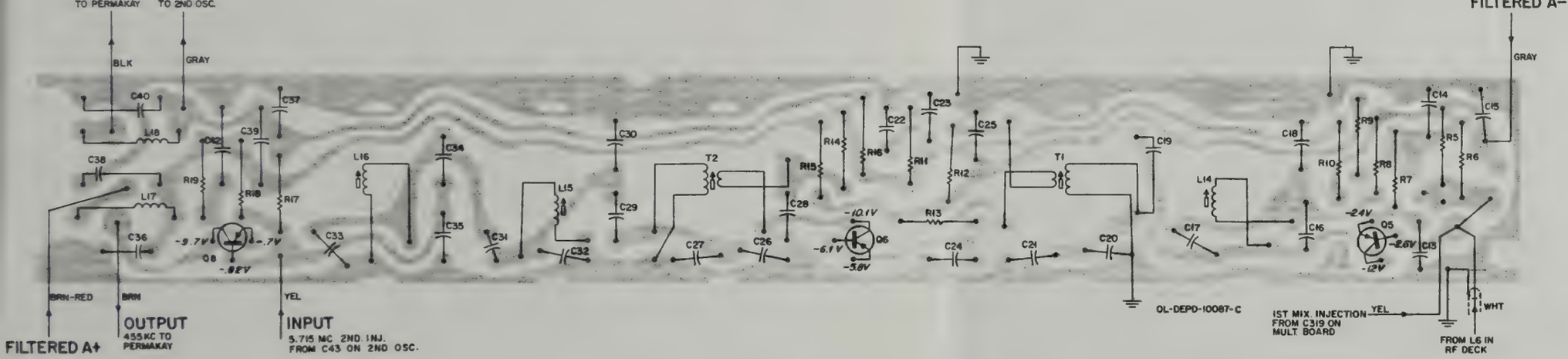
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed:
C43	21K872060 or	30 uuf ±5%; 1500 v (TLN6624A)
	21D82355B24	24 uuf ±5%; 500 v (TLN6624AH)
C44	21K865441	170 uuf ±3%; 500 v
C45, 45, 47	21D82428B26	.02 uf +80-20%; 200 v
		TRANSISTOR, P-N-P: NOTE I
Q7	48R869003	type M9003
		RESISTOR, fixed: ±10%; 1/2 w; unl. stated
R21	6S5726	15K ±5%
R22	6S6410	33K
R23	6S3940	5.6K ±5%
R24	6S6326	100
		CRYSTAL UNIT, quartz: NOTE II
	G10	5.715 mc (TLN6624A)
Y1	or AH	6.915 mc (TLN6624AH)
NON-REFERENCED ITEMS		
	1V80728A44	CIRCUIT BOARD ASSY. (eyeleted)

NOTES:

I. Replacement transistors must be ordered by Motorola part number only for optimum performance.

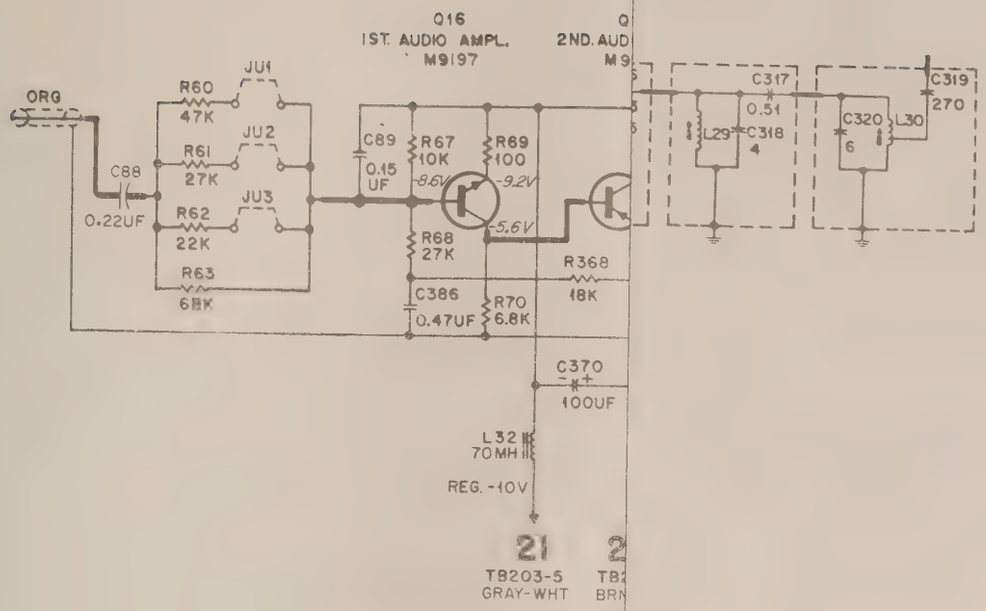
II. Crystals are part of the Radio Set Model only. When ordering crystal units specify car. freq(s), crystal freq(s), crystal type number.

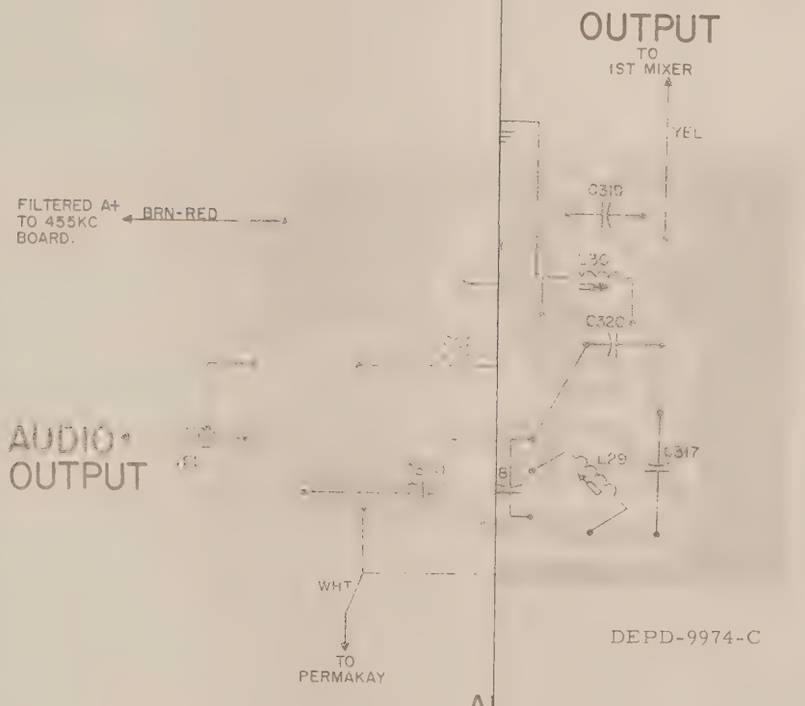




PREVIOUS REVISIONS AND PARTS LIST
SHOWN ON BACK OF THIS DIAGRAM

5.26 MC IF Circuit Board Detail
Model TLN6621B-5 used in
152-162 MC, 20 W, ±12 V DC
Motorola Car Telephone Receiver
Motorola No. EPD-10088-K (SMR-1112G)
1/17/72-





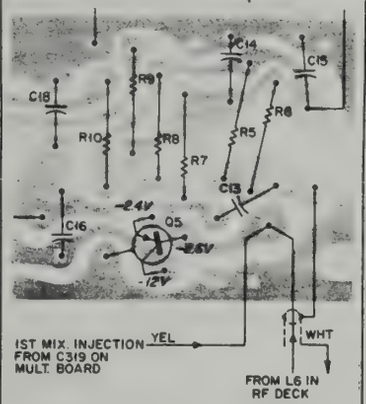
DEPD-9974-C

IOUS REVISIONS AND PARTS LISTS
N ON BACK OF THIS DIAGRAM

-First Oscillator Multiplier
it Board Detail
TLN6622B-5 Used in
62 MC, 20 W, ±12 V DC
ola Car Telephone Radio Set
ola No. EPD-9975-G (SMR-400A)
69.

REVISIONS

EPD-10088-K

BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
TLN6621B		BRN OUTPUT LEAD WAS RED	COLLECTOR OF Q8
		TRANSISTOR REFERENCE SYMBOLS ADDED	
TLN6621B-1	C13	RELOCATED CIRCUIT WAS AS SHOWN BELOW	Q5 EMITTER
			
TLN6621B-1	Q8	WAS 48R839133	PARTS LIST
TLN6621B-1	L14, 15, 16, T1, T2	TUNING CORE WAS 1V80728A92	PARTS LIST
TLN6621B-2	Q5	WAS 48R869085, TYPE M9085	1ST MIXER
	Q8	WAS 48R869133, TYPE M9133	2ND MIXER
TLN6621B-3	C14, 15, 18, 22, 23, 25, 28, 36, 37	WERE 21D82428B18 .02 uf +60-40%; 100 V	PARTS LIST
TLN6621B-3	Q8	WAS 48R869404	PARTS LIST
	Q8	WAS 48R869403, M9403	2ND MIXER
TLN6621B-4		REMOVED CONNECTION BETWEEN GROUND AND Q5 CASE	RIGHT SIDE OF BD.
TLN6621B-5	C19	FROM 21K830200, 0.2 uuF TO 21C82450B01, 0.3 uuF	T1
	C22	FROM 21D82428B26, .02 uF +80-20%: 200 V TO 8D82905G23, .02 uF ±10%; 100 V	Q6 BASE CIRCUIT
	C28		Q6 COLL.
	C24	FROM 21C82187B17, 820 uuF ±10%; 500 V TO 21K873269, 820 uuF ±2%; 300 V	Q6 EMITTER
	C29, 31	FROM 21K867162, 0.24 uuF TO 21C82450B07, 0.39 uuF	L15

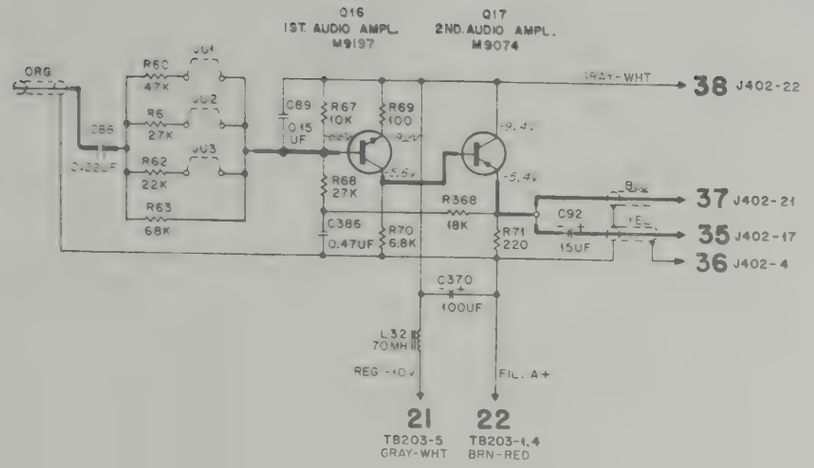
PARTS LIST

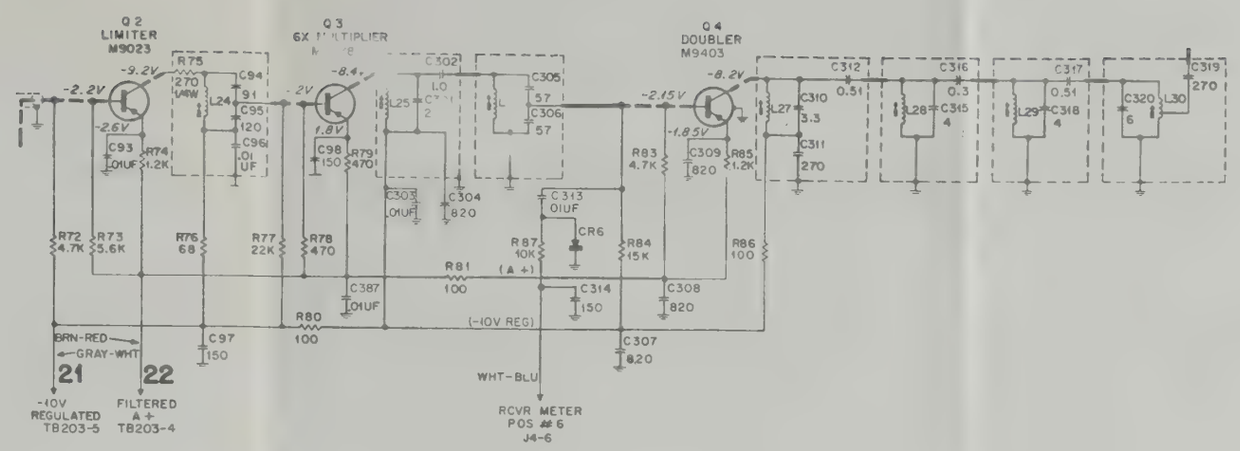
TLN6621B 1st IF Circuit Board — EPD-20364-D

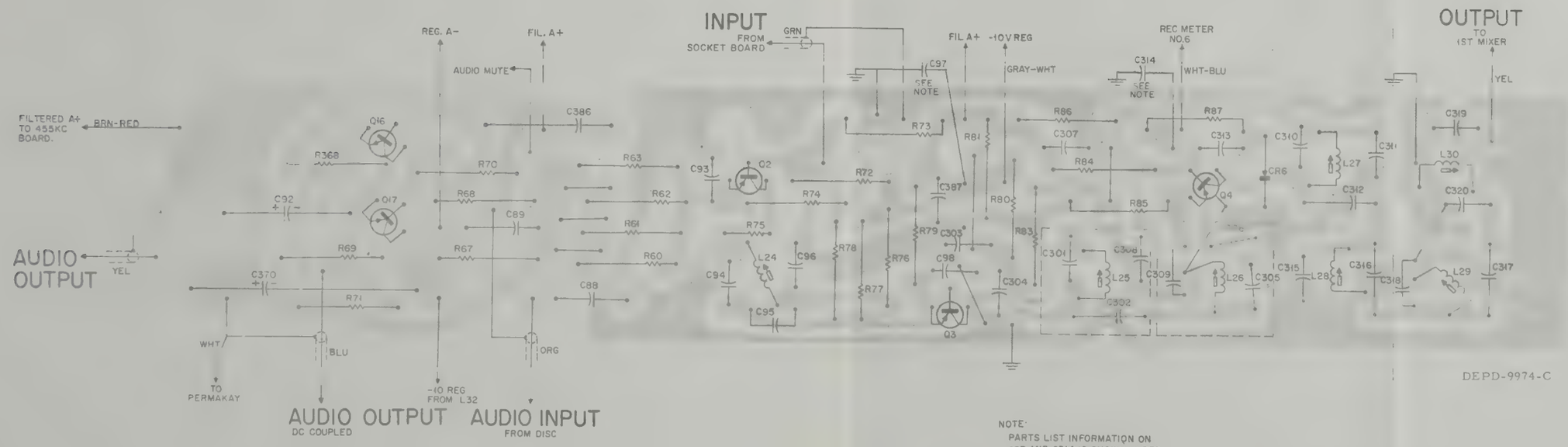
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uuf; unl. stated
C13	21C82187B18	1500 ±10%; 100 v
C14, 15, 18, 23, 25, 36, 37	21D82428B26	.02 uf +80-20%; 200 v
C16, 20, 27, 32	21K873266	68 ±2%; 500 v
C17, 21, 26	21C82610C31	36 ±5%; 200 v; N220
C19	21C82450B01	0.3 ±5%; 500 v
C22, 28	8D82905G23	.02 uF ±10%; 100 v
C24	21K873269	820 ±2%; 300 v
C29, 31	21C82450B07	0.39 ±5%; 500 v
C30	21D82610C32	36 ±5%; 200 v;;N330
C33	21D82133G04	12 ±5%; 500 v; N750
C34	21K850118	100 ±5%; 500 v
C35	21K873269	820 ±2%; 300 v
C38, 39, 40	8D82905G30	0.1 uf ±10%; 50 v
C42	8D82905G02	.022 uf ±10%; 25 v
		COIL, RF:
L14, 15, 16	24V80902A08	BLU; incl. 76B82888D02 CORE; tuning
L17, 18	24D82135G01	choke; 0.62 mh
		TRANSISTOR, P-N-P; NOTE I
Q5	48R869404	type M9404
Q6	48R869023	type M9023
Q8	48R869204	type M9204
		RESISTOR, fixed: ±10%; 1/4 w; unl. stated
R5	6S128686	8.2K
R6	6K127802	1K
R7	6S129235	1.2K
R8, 9, 10, 14, 15, 16	6S129753	100
R11, 12	6S129231	3.3K
R13	6S129432	820
R17	6K129433	5.6K
R18, 19	6K129775	330
		TRANSFORMER,
T1	24V80902A09	RED; incl. 76B82888D02 CORE; tuning
T2	24V80902A10	YEL; incl. 76B82888D02 CORE; tuning
NON-REFERENCED ITEMS		
	26C82072G01	SHIELD, coil: 5 used
	1V80740A23	CIRCUIT BOARD ASSY. (eyeleted)

NOTE:

Replacement transistors must be ordered by Motorola part number only for optimum performance.





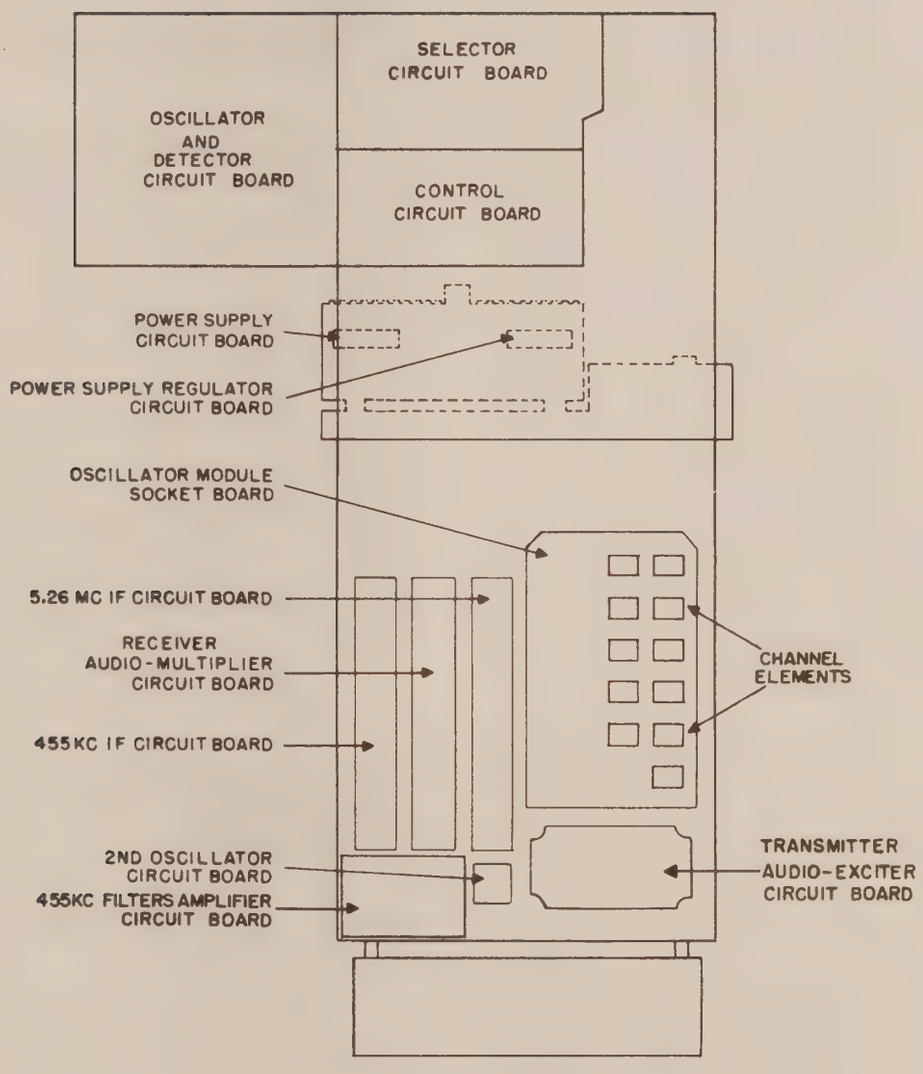


DEPD-9974-C

NOTE:
PARTS LIST INFORMATION ON C97 AND C314 IS SHOWN UNDER TLN6627B UNIT COMPONENT KIT

PREVIOUS REVISIONS AND PARTS LISTS SHOWN ON BACK OF THIS DIAGRAM

Audio-First Oscillator Multiplier
Circuit Board Detail
Model TLN6622B-5 Used in
152-162 MC, 20 W, ±12 V DC
Motorola Car Telephone Radio Set
Motorola No. EPD-9975-G (SMR-400A)
7/11/59.



TOP VIEW

Circuit Board Location Detail
For 152-162 MC, 20 W, ±12 V
Motorola Car Telephone Radio Sets
Motorola No. BEPD-10443-A
8/24/64-

REVISIONS

EPD-9975-G

BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
TLN6622B-	C92	POLARITY REVERSED	EMITTER OF Q17
		BRN-RED LEAD ADDED	UPPER LEFT PORTION OF BOARD
		WHT LEAD ADDED	EMITTER OF Q17
TLN6622B-1	C97	REMOVED, 21C82428B02, .01 uf	ABOVE Q3
	C314	REMOVED, 21C82428B02, .01 uf	REC. METER NO. 6 WHT-BLU LEAD
TLN6622B-2	Q4	WAS 48R869085 TYPE M9085	Q4
TLN6622B-3	C93, 96, 98, 303, 313, 387	WERE 21C82428B02, .01 uf +70-30%; 100 V	PARTS LIST
TLN6622B-3	C96	WAS 21C82428B58, .01 uf, 500 V	PARTS LIST
TLN6622B-4	Q4	WAS 48R869403	PARTS LIST
	C98	WAS 21C82428B58 .01 uf	Q3 EMITTER
TLN6622B-5			

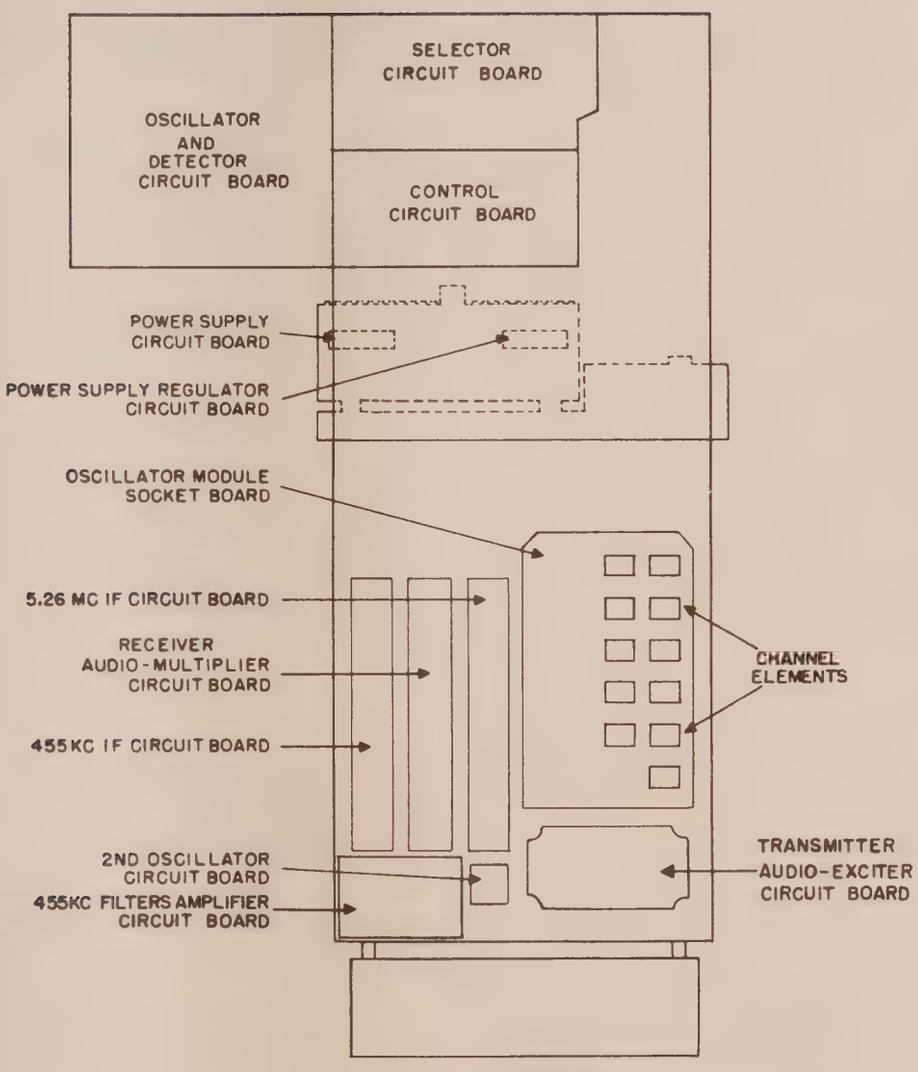
PARTS LIST

TLN6622B Multiplier & Audio Board PL-622-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uuf;
C88	8D82905G11	.22 uf ±10%; 25 v
C89	8D82905G05	.15 uf ±10%; 25 v
C92	23K865136	15 uf ±20%; 25 v
C93, 303, 313, 387	21C82428B58	.01 uf +80-20%; 500 v
C94	21K865448	91 ±3%; 500 v
C95	21K840713	120 ±5%; 500 v
C96	21D82428B59	.01 uf +80-20%; 200 v
C98	21D82187B32	150 ±10%; 500 v
C301	21K865066	27 ±5%; N150
C302	21D82450B28	1.0 ±10%; 500 v
C304, 307, 308, 309	21C82187B21	820 ±10%; 200 v
C305, 306	21D82610C05	57 ±5%; N150
C310	21D82610C35	3.3 ±5%; N150
C311, 319	21C82187B22	270 ±10%; 200 v
C312, 317	21K859678	.51 ±5%; 500 v
C315, 318	21D82610C36	4 ±0.5; 250 v; N150
C316	21K830201	0.3 ±5%; 500 v
C320	21K847082	6 ±10%; 250 v; N150
C370	23D82601A25	100 uf +150-10%; 20 v
C386	8D82905G06	.47 uf ±10%; 25 v
		SEMICONDUCTOR DEVICE, diode: SEE NOTE
CR6	48C82921G01	germanium
		COIL, RF:
L24	24V80903A11	incl. 76B82572G03 CORE, tuning
L25 thru 29	24B83090A01	incl. 76B82572G03 CORE, tuning
L30	24B83090A02	incl. 76B82572G03 CORE, tuning
		TRANSISTOR: SEE NOTE
Q2	48R869023	P-N-P; type M9023
Q3	48R869078	P-N-P; type M9078
Q4	48R869425	P-N-P; type M9425
Q16	48K869197	N-P-N; type M9197
Q17	48R869074	P-N-P; type M9074
		RESISTOR, fixed: ±10%; 1/2 w
R60	6R6048	47K
R61, 68	6R6434	27K
R62, 77	6R6397	22K
R63	6R6074	68K
R67, 87	6R6320	10K
R69, 80, 81, 86	6R6326	100
R70	6R6428	6.8K
R71	6R6270	220
R72, 83	6R6080	4.7K
R73	6R6117	5.6K
R74, 85	6R6393	1.2K
R75	6K129752	270; 1/4 w
R76	6R2039	68
R78, 79	6R6090	470
R84	6R6477	15K
R368	6R5591	18K
NON-REFERENCED ITEMS		
	1V80737A54	CIRCUIT BOARD ASSY, (eyeleted)
	26A82076C03	SHIELD, coil; 7 used
	14A82618C03	INSULATION, coil; 7 used

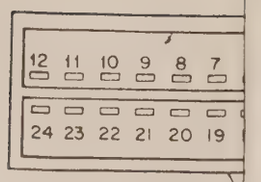
NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.



TOP VIEW

Circuit Board Location Detail
For 152-162 MC, 20 W, ±12 V
Motorola Car Telephone Radio Sets
Motorola No. BEPD-10443-A
8/24/64-



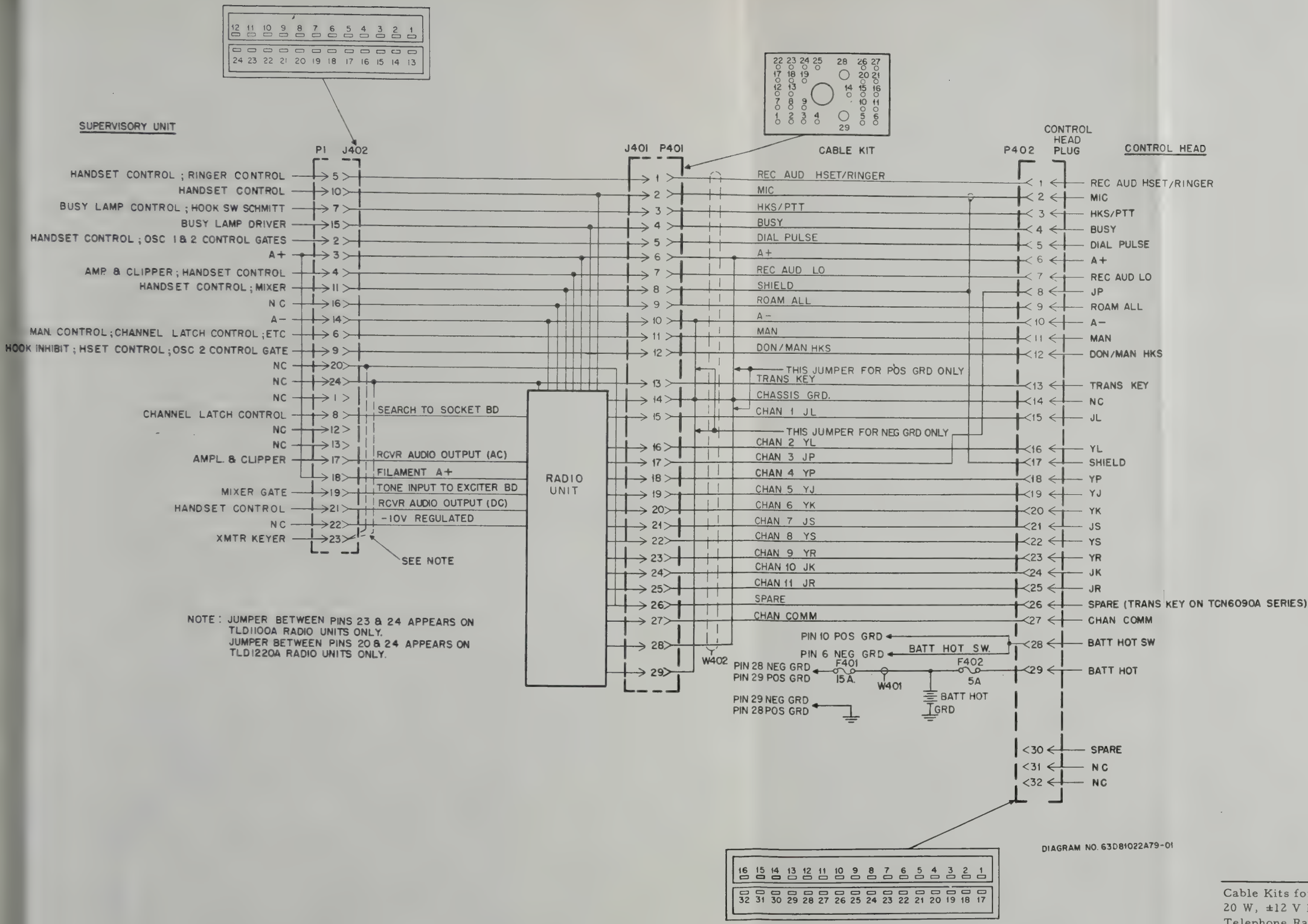
SUPERVISORY UNIT

PI OL HEAD

HANDSET CONTROL ; RINGER CONTROL →
HANDSET CONTROL → T/RINGER
BUSY LAMP CONTROL ; HOOK SW SCHMITT →
BUSY LAMP DRIVER →
HANDSET CONTROL ; OSC 1 & 2 CONTROL GATES →
A+ →
AMP. & CLIPPER ; HANDSET CONTROL →
HANDSET CONTROL ; MIXER →
N C →
A− →
MAN. CONTROL ; CHANNEL LATCH CONTROL ; ETC →
HOOK INHIBIT ; HSET CONTROL ; OSC 2 CONTROL GATE →
NC →
NC →
NC →
CHANNEL LATCH CONTROL →
NC →
NC →
AMPL. & CLIPPER →
→
MIXER GATE →
HANDSET CONTROL →
N C →
XMTR KEYER →

NOTE : JUMPER BETWEEN P KEY ON TCN6090A SERIES)
TLD1100A RADIO UNI
JUMPER BETWEEN PI
TLD1220A RADIO UNI

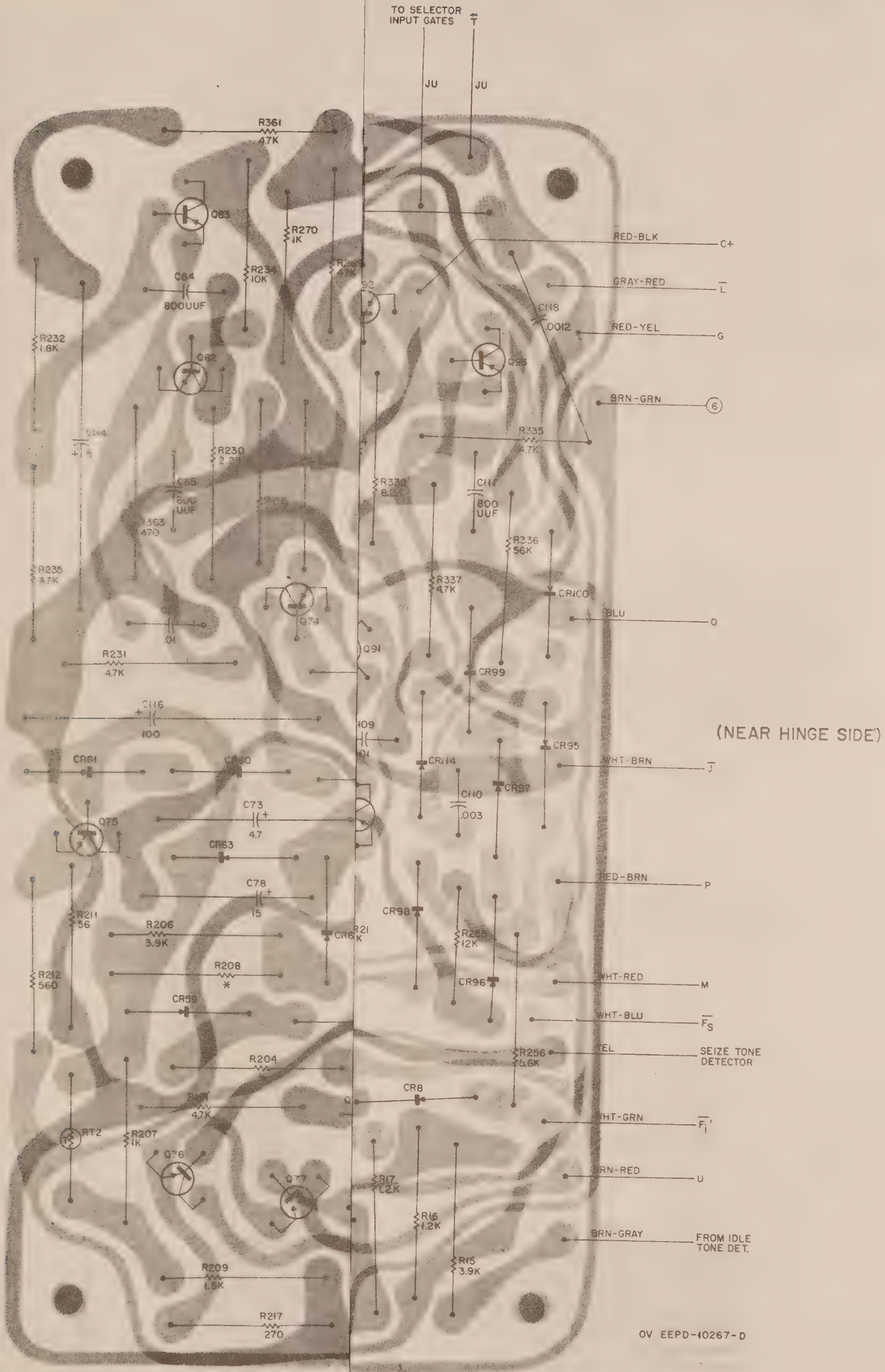
Cable Kits for 152-162 MC,
20 W, ±12 V DC Motorola Car
Telephone Radio Set
Intercabling Diagram
Motorola No. 63D81022A79-O1 (T-2518A)
2/23/67



NOTE: JUMPER BETWEEN PINS 23 & 24 APPEARS ON TLD1100A RADIO UNITS ONLY.
JUMPER BETWEEN PINS 20 & 24 APPEARS ON TLD1220A RADIO UNITS ONLY.

DIAGRAM NO. 63D81022A79-01

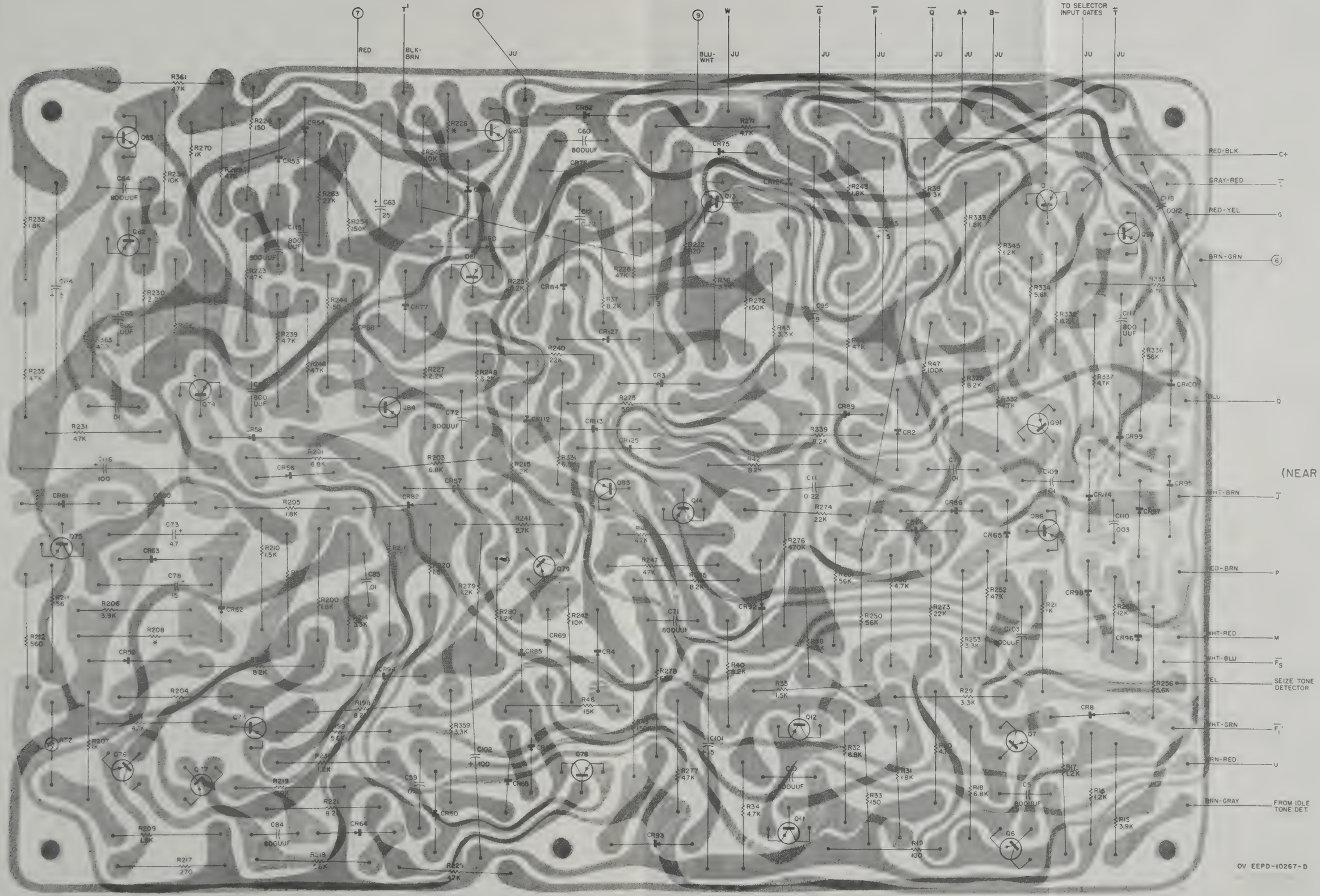
Cable Kits for 152-162 MC,
20 W, ±12 V DC Motorola Car
Telephone Radio Set
Intercabling Diagram
Motorola No. 63D81022A79-O1 (T-2518A)
2/23/67


TO SELECTOR INPUT GATES
JU
JU
R361 4.7K
Q83
R270 1K
C64 800UUF
R234 10K
R232 1.8K
Q82
R230 2.2K
C65 800 UUF
R363 470
R235 4.7K
.01
R231 4.7K
Q74
Q91
C116 100
CR61
CR60
C73 4.7
Q75
CR63
C78 15
R211 56
R206 3.9K
R208 *
R212 560
CR59
R204
R207 1K
RT2
Q76
Q77
R209 1.5K
R217 270
R335 4.7K
R336 56K
R337 4.7K
CR100
CR99
CR95
CR94
CR97
C110 .003
CR98
R255 12K
CR96
R256 5.6K
CR8
R17 1.2K
R16 1.2K
R15 3.9K
RED-BLK C+
GRAY-RED L
RED-YEL G
BRN-GRN 6
BLU Q
WHT-BRN J
RED-BRN P
WHT-RED M
WHT-BLU FS
SEIZE TONE DETECTOR
WHT-GRN FI'
BRN-RED U
BRN-GRAY FROM IDLE TONE DET.
(NEAR HINGE SIDE)
OV EEPD-10267-D

PARTS LIST

TKN6178A (Pos. ground)
TKN6142B (Neg. ground)
TKN6156B (Pos. gnd., for battery saver)
TKN6157B (Neg. gnd., for battery saver) EPD-10693-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		FUSE, cartridge:
F401	65R4165	15 amp. 32 v
F402	65R52293	5 amp; 250 v
		CONNECTOR, plug:
P401		incl. 9C82547E01 CONNECTOR, plug: female 29 contacts 1V80717A73 SCREW & KNOB ASSY: 15D82075D01 HOUSING, connector: right hand 15D82075D03 HOUSING, conn; left hand 4A800671 WASHER: .016" thick 4A82113D01 WASHER: .032" thick 4A11722 WASHER, "C" 42C864148 CLAMP, cable 3S132127 SCREW, tapping: #6 x 3/4"; 2 used 3S131758 SCREW, machine: #40-40 x 1/8"; 2 used 2S129924 NUT, hex: #4-40 x 1/4"; 2 used
P402	1V80730A92	assy; incl. 9C82152G01 CONNECTOR; plug; female; 32 cont. and 42A82230G01 CLAMP, cable
		CABLE ASSY.; special purpose:
W401	1V864644	incl. 30K858553 CABLE power: 1 cond. #12 ga. RED; 22-1/2' used; 29K832116 LUG for 3/8" stud and ref parts F401 and XF401 (TLN6142B)
	or 1V80729A58	incl. 30B82724C02 CABLE, POWER: 1 cond. #12 BLUE; 22-1/2' used; 29K832116 LUG for 3/8" stud and ref part F401 and XF401 (TLN6178A) 26 cond.; 20 ft. length req'd
		FUSEHOLDER:
XF401		incl. 14A82882A01 BODY, fuseholder; 14A82883A01 CAP; fuseholder; 42A82884A01 CLIP, fuseholder: 2 req'd 41A82885A01 SPRING, fuseholder
XF402	1V80739A76	incl. ref part F402 and the following items: 14A82882A01 BODY fuseholder 14A82883A01 CAP, fuseholder 41A82885A01 SPRING, fuseholder 1V80739A77 FUSE CLIP & LEAD ASSY; #18 ga GRN; 97" long 1V80739A78 FUSE CLIP & LEAD ASSY; #18 ga GRN; 9" long


7
T'
8
9
W
G
P
Q
A+
B−
TO SELECTOR INPUT GATES
T
RED
BLK-BRN
JU
BLU-WHT
RED-BLK
C+
GRAY-RED
T
RED-YEL
G
BRN-GRN
6
BLU
Q
(NEAR HINGE SIDE)
WHT-BRN
J
RED-BRN
P
WHT-RED
M
WHT-BLU
F5
YEL
SEIZE TONE DETECTOR
WHT-GRN
F1
BRN-RED
U
BRN-GRAY
FROM IDLE TONE DET.
OV EEPD-10267-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R227, 230	6S6069	2.2K
R234, 242, 249	6R6320	10K
R240, 273, 274,	6S6397	22K
R241	6R5577	2.7K
R250, 251, 275, 336	6R6378	56K
R255	6R2075	12K ±5%
R263	6R6434	27K
R276	6R6377	470K
R278	6S6040	680
R363	6S400812	470 ±5%
RT2	6K858402	THERMISTOR: 1K @ 25°C

NOTE:

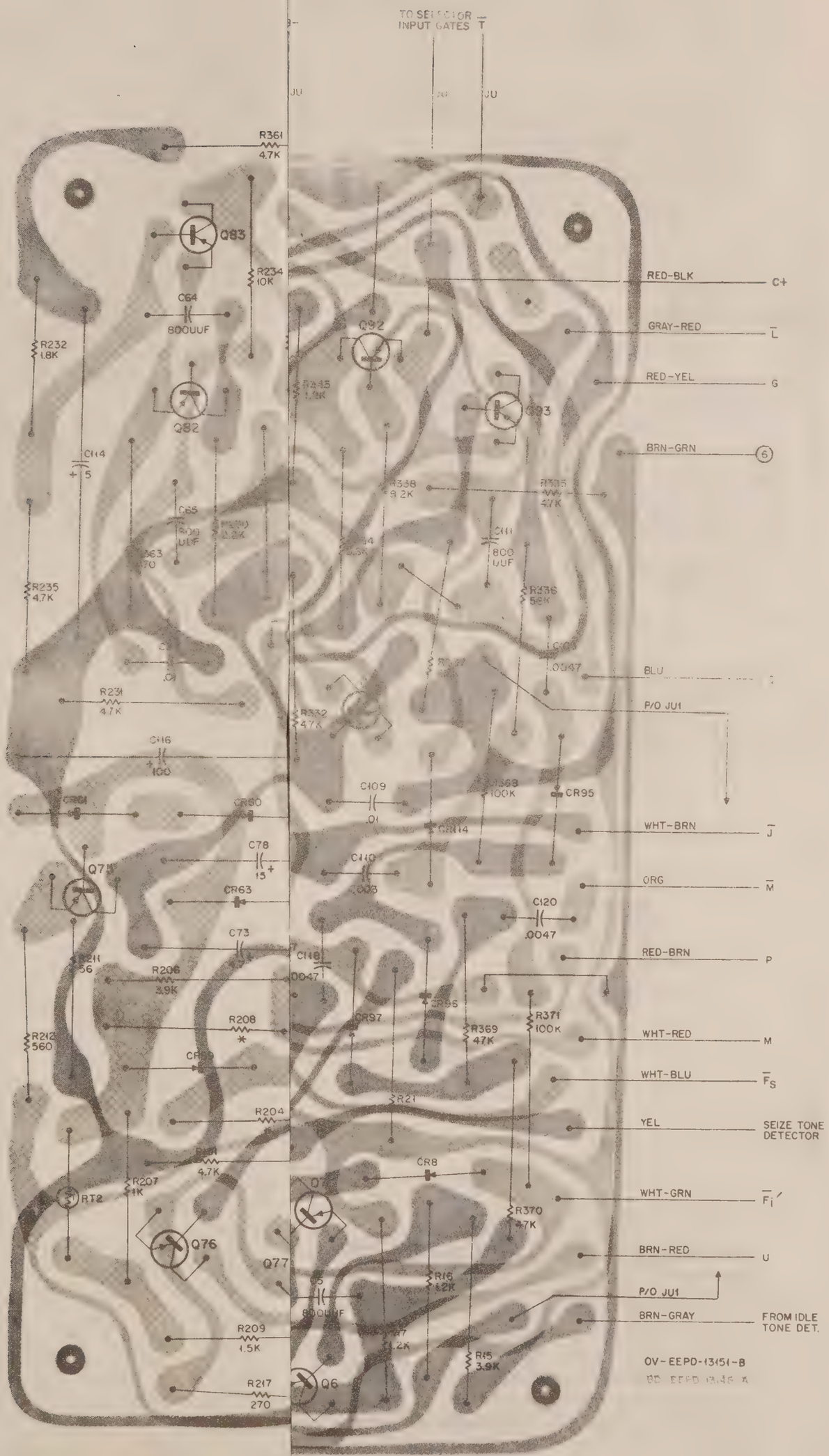
Replacement transistors and diodes must be ordered by Motorola part number only for optimum performance.

nstruction manual revision MR-1815B

For 68P81029A35-O

Add this EPD-10268-G to your Supervisory Unit Section.

Also used in 68P81022A65
68P81028A60


TO SELECTOR INPUT GATES
R361 4.7K
Q83
R234 10K
C64 800UUF
Q82
R232 1.8K
C114 15
R235 4.7K
R231 4.7K
C116 100
C78 15
Q75
CR63
C73
R211 56
R206 3.9K
R208 *
R212 560
R204
R207 1K
RT2
Q76
R209 1.5K
R217 270
Q92
Q93
R368 9.2K
R336 47K
C111 800 UUF
R236 56K
C109 .01
R332 47K
R368 100K
CR95
CR94
C110 .003
C120 .0047
CR96
CR97
R369 47K
R371 100K
R21
CR8
Q77
R370 4.7K
R15 1.2K
R17 1.2K
R15 3.9K
C5 800UUF
RED-BLK C+
GRAY-RED L
RED-YEL G
BRN-GRN 6
BLU
P/O JU1
WHT-BRN J
ORG M
RED-BRN P
WHT-RED M
WHT-BLU FS
YEL SEIZE TONE DETECTOR
WHT-GRN Fi'
BRN-RED U
P/O JU1
BRN-GRAY FROM IDLE TONE DET.
OV-EEPD-13151-B

REVISIONS

DIAG. ISSUE	BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
A	TLN6816A	R15	WAS 3.3K	
			RED AND GREY COLORS WERE REVERSED	
B	TLN6816A	R39	WAS 4.7K	Q1 BASE
C	TLN6816A-1	R17	WAS 1.8K	Q6 COLLECTOR
		R19	WAS 150	Q6 EMITTER
		R21	WAS 1.5K	Q7 COLLECTOR
		R38	WAS 5.6K	Q13 BASE
		R363	WAS 270	Q82 EMITTER
D	TLN6816A-2	C75	WAS 21K847070, 800 uuf	Q86 COLLECTOR
		C118	ADDED .0012 uf	UPPER RIGHT OF BOARD
			ADDED ORG LEAD BETWEEN JUNCTION OF CR66, R250, R251 AND C118	
E			ADDED MODEL TABLE	
F	TLN6816A-3	CR82, 94	WERE 48C82178A01	PARTS LIST
G	TLN6816A-4		EXTENSIVE CIRCUIT BOARD CHANGES	REFER TO EPD-13150-O

NOTES:

1. UNLESS OTHERWISE STATED CAPACITOR VALUES ARE IN MICROFARADS.
2. UNLESS OTHERWISE STATED RESISTOR VALUES ARE IN OHMS, K = 1000.
3. LEADS ENDING IN LETTER DESIGNATIONS A THROUGH E REFER TO DESTINATIONS IN THE FILTER AND BIAS SUPPLY.
4. LEADS ENDING IN LETTER DESIGNATIONS F THROUGH W REFER TO DESTINATIONS IN OTHER CIRCUITS. LETTERS WITH BARS OVER THEM INDICATE NEGATIVE GOING OUTPUTS. REFER TO THE CIRCUIT ROUTING CHART IN THE INSTRUCTION MANUAL.
5. CIRCLED NUMBERS INDICATE ELECTRICAL CONNECTIONS TO PLUG P1.
6. * ASTERISK DENOTES FACTORY SELECTED COMPONENT.
7. THE PRINTED CIRCUIT BOARD IS INDICATED IN GREY: THE LAMINATE IS INDICATED IN RED.

EPD-10486-A

MODEL TABLE

MODEL	SUFFIX	DESCRIPTION
TLN6816A	3	CONTROL CIRCUIT BOARD

EPD-13240-A

FOR UNITS SUFFIXED LATER THAN INDICATED IN THE ASSOCIATED MODEL TABLE REFER TO EPD-14150.

EPD-14024-O

PREVIOUS REVISIONS LISTED ON BACK OF THIS DIAGRAM

Control Circuit Board Detail
Model TLN6816A used in
152-162 MC, 20 W, ±12 VDC
Motorola Car Telephone Radio Set
And IMTS Control Terminal
Motorola No. EPD-10268-G
11/25/65-

PARTS LIST for Diagram EPD-10268-G

TLN6816A Control Board

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uf: unl stated
C5, 10, 60, 61, 64, 65, 69, 71, 72, 84, 103, 111, 115	21K847070	800 uuf ±10%; 600 v
C11, 12	8D82905G11	0.22 ±10%; 25 v
C59	8C82095G06	0.1 ±10%; 200 v
C67, 75, 83, 109	21D82428B21	.01 +10-30%; 100 v
C73, 81, 86, 87	23K865137	4.7 ±20%; 25 v
C78	23K865136	15 ±20%; 25 v
C85, 95, 101, 114	23D82601A11	5 +33-10%; 25 v
C102, 116	23D82783B04	100 ±20%; 25 v
C114	21C82187B16	.003 ±10%; 100 v
C117	23D82601A15	3 +150-10%; 100 v
C118	21D82428B23	.0012 ±10%; 100 v
		SEMICONDUCTOR DEVICE, diode: (NOTE)
CR2, 3, 4, 8, 50, 52, 53, 54, 56, 58, 59, 60, 61, 64 thru 69, 75, 76, 79, 80, 84, 85, 86, 88, 89, 92, 93, 95 thru 100, 113, 114, 125, 126, 127	48C82392B03	silicon
CR57, 62, 63, 77, 112	48C82178A01	germanium
CR82, 94	48C82466H01	silicon
		TRANSISTOR: (NOTE)
Q6, 11, 13, 14, 73, 75, 91	48K869161	germanium; P-N-P; M9161
Q7, 12, 76, 77, 78, 81, 82, 83, 92	48R869160	germanium; P-N-P; M9160
Q74, 79, 80, 84, 85, 86, 93	48K869208	germanium; P-N-P; M9208
		RESISTOR, fixed: ±10%; 1/2 w
R15, 29	6R2024	3.9K ±5%
R16, 17, 58, 215, 238, 279, 280, 345	6R6166	1.2K ±5%
R18, 32	6R6428	6.8K
R19	6R6408	100 ±5%
R20, 34, 229, 231, 235, 239, 271, 277, 335, 361	6R6080	4.7K
R21, 207	6S6411	1K ±5%
R33	6R5645	150 ±5%
R35, 209, 210	6R400459	1.5K ±5%
R36, 43, 236, 253	6R5581	3.3K
R37, 40, 42, 198, 225, 245, 248, 328, 339	6R400490	8.2K ±5%
R38, 41, 191, 228, 246, 247, 332, 337, 362	6R3924	4.7K ±5%
R39, 214, 359	6R2003	3.3K ±5%
R44, 223, 252, 269	6R6048	47K
R45, 254, 272	6R6398	150K
R46	6R6477	15K
R47	6R6031	100K
R199, 256, 334	6R3940	5.6K ±5%
R200, 205, 232, 243	6R2089	1.8K
R201, 203, 213, 331	6R2001	6.8K ±5%
R202, 221	6R2004	8.2K
R206, 219	6R5659	3.9K
R211	6R5673	56 ±5%
R212	6R400058	560 ±5%
R216	6S5652	2.7K ±5%
R217	6S400057	270 ±5%
R218	6R6117	5.6K
R220	6S129681	1.5K ±5%
R222	6S119172	820 ±5%
R224	6R6373	150
R227, 230	6S6069	2.2K
R234, 242, 249	6R6320	10K
R240, 273, 274,	6S6397	22K
R241	6R5577	2.7K
R250, 251, 275, 336	6R6378	56K
R255	6R2075	12K ±5%
R263	6R6434	27K
R276	6R6377	470K
R278	6S6040	680
R363	6S400812	470 ±5%
		THERMISTOR:
RT2	6K858402	1K @ 25°C

NOTE:

Replacement transistors and diodes must be ordered by Motorola part number only for optimum performance.

instruction manual revision MR-1815B

For 68P81029A35-O

Add this EPD-10268-G to your Supervisory Unit Section.

Also used in 68P81022A65
68P81028A60

RED-BLK — C+

GRAY-RED — $\overline{L}$

RED-YEL — G

BRN-GRN — 6

WHT-BRN — $\overline{J}$

ORG — $\overline{M}$

RED-BRN — P

WHT-RED — M

WHT-BLU — $\overline{F_S}$

YEL — SEIZE TONE DETECTOR

WHT-GRN — $\overline{F_1}$

BRN-RED — U

BRN-GRAY — FROM IDLE TONE DET.

P/O JU1

OV-EEPD-13151-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R227, 230	6S6069	2.2K
R234, 242, 249	6R6320	10K
R240, 273, 274	6S6397	22K
R241	6R5577	2.7K
R250, 251, 275, 336, 367	6R6378	56K
R263	6R6434	27K
R270	6S6229	1K
R276	6R6377	470K
R278	6S6040	680
R363	6S400812	470 ±5%
		THERMISTOR:
RT2	6B858402	1K @ 25°C

NOTE:

Replacement transistors and diodes must be ordered by Motorola part number only for optimum performance.


C76
100
C20
T1
+ C43
15
255
3.3K
R53
220
R56
4.7K
BRN-YEL
A+
YEL
TO SEIZE TONE SCHMITT TRIGGER
BRN-GRAY
TO IDLE TONE SCHMITT TRIGGER
R72
33K
CR74
R257
33
C21
.01
C77
Q87
CR101
C8
.3
Q18
4
C15
800UUF
C14
800 UUF
WHT-BRN
J
ORG
17
C16
0.22
R52
Q17
R54
82K
R260
8.2K
080
800UUF
R262
1.8K
R2
100
RED-ORG
J
R259
4.7K
Q88
CR71
800UUF
WHT-BLU
$\overline{F_S}$
Q16
R49
68
R264
15K
R261
27K
C103
C104
800 UUF
R50
R51
3.3K
RED-GRN
W
C81
47
R57
1.2K
BRN-GRN
6
CR72
CR102
Q15
WHT-GRN
$\overline{F_1}$
Q89
Q90
R266
4.7K
R268
3.2K
6.8K
C94
C82
800 UUF
C94
C94
Q82
R158
10K
CR116
2
1
T2
C94
R246
6.8K
4
3
Q61
5
R155
4.7K
R315
5.6K
R316
680
R152
4.7K
Q101
R313
3.3K
R312
12K
Q60
R314
5.1K
C93
068
C92
2
R153
18
Q100
86
80
R311
1K
R187
10
Q94
R284
470
R288
56K
35
K
R294
*
CR104
RED BLK
RED WHT
GR
C+
$\overline{K}$
BRN-BLU
TO Q21 COLLECTOR
YEL-BRN
$\overline{Q}$
0L-EEPD-10275-G
0

REVISIONS

EPD-13150-B

	BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
WAS EPD-10268-G	TLN6816A-4		EXTENSIVE CIRCUIT BD. CHANGES	
	TLN6816A-5	CR129	ADDED 48C82392B03	Q78 BASE
	TLN6816A-5	C63, 110 R31, 333, 338	ADDED	PARTS LIST
	TLN6816A-5	JU1	ADDED (IN EARLY PRODUCTION UNITS. CONTINUITY WAS MADE BY COPPER PLATING ON THE BOARD.)	LEFT SIDE OF BOARD

NOTES:

1. UNLESS OTHERWISE STATED CAPACITOR VALUES ARE IN MICROFARADS.
2. UNLESS OTHERWISE STATED RESISTOR VALUES ARE IN OHMS, K = 1000.
3. LEADS ENDING IN LETTER DESIGNATIONS A THROUGH E REFER TO DESTINATIONS IN THE FILTER AND BIAS SUPPLY.
4. LEADS ENDING IN LETTER DESIGNATIONS F THROUGH W REFER TO DESTINATIONS IN OTHER CIRCUITS. LETTERS WITH BARS OVER THEM INDICATE NEGATIVE GOING OUTPUTS. REFER TO THE CIRCUIT ROUTING CHART IN THE INSTRUCTION MANUAL.
5. CIRCLED NUMBERS INDICATE ELECTRICAL CONNECTIONS TO PLUG P1.
6. * ASTERISK DENOTES FACTORY SELECTED COMPONENT.
7. THE PRINTED CIRCUIT BOARD IS INDICATED IN GREY; THE LAMINATE IS INDICATED IN RED.

EPD-10486-A

MODEL TABLE

MODEL	SUFFIX	DESCRIPTION
TLN6816A	5	CONTROL CIRCUIT BOARD

EPD-12426-A

FOR UNITS SUFFIXED EARLIER THAN INDICATED IN THE FOLLOWING TABLE, REFER TO EPD-10268.

MODEL	SUFFIX
TLN6816A	4

EPD-14025-O

PREVIOUS REVISIONS AND PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

Control Circuit Board Detail
Model TLN6816A used in
152-162 MC, 20 W, ±12 VDC
Motorola Car Telephone Radio Set
And IMTS Control Terminal
Motorola No. EPD-13150-B (SMR-742A)
6/9/70-

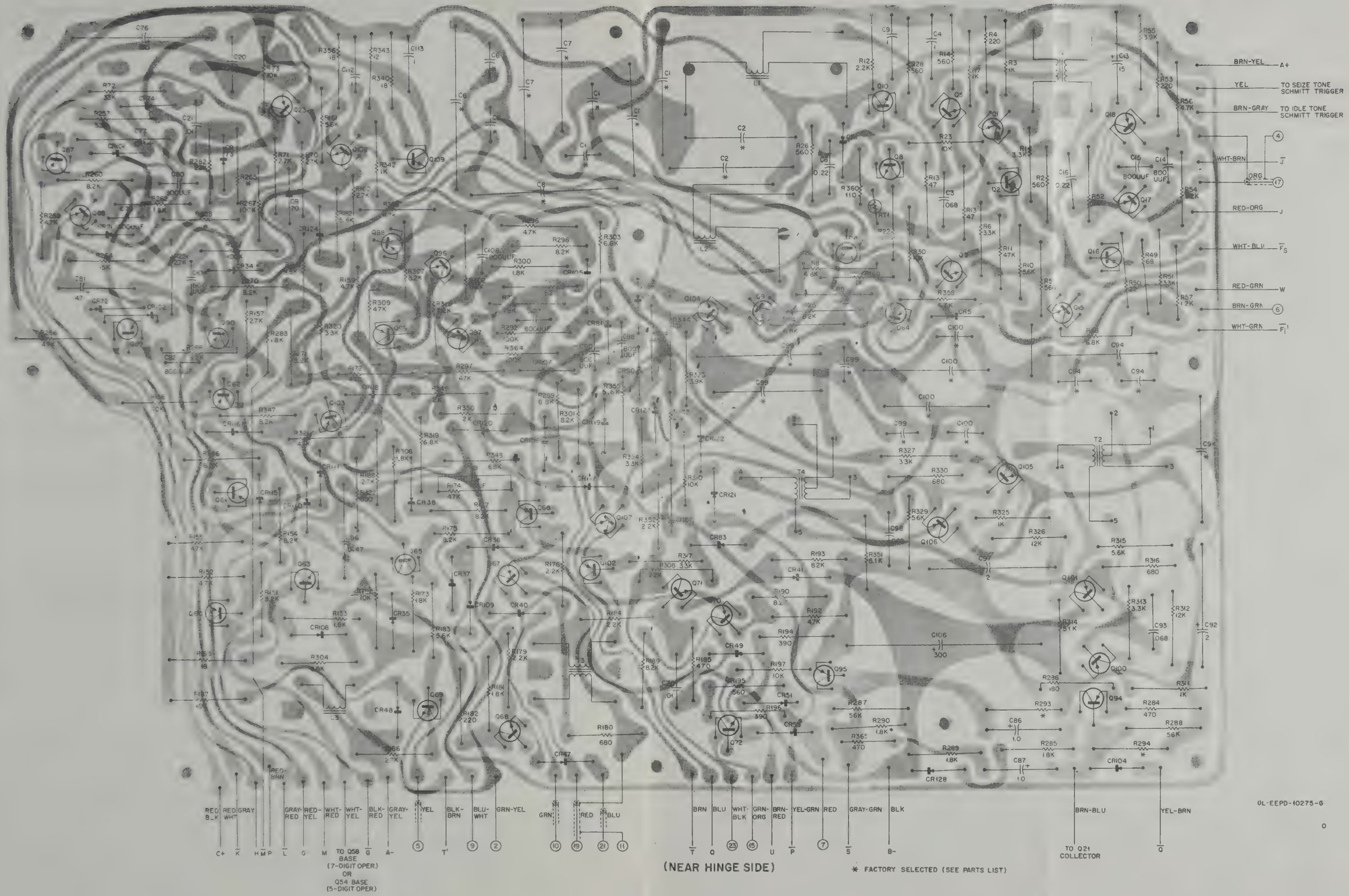
PARTS LIST

TLN6816A Control Board — PL-987-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uf; unl stated
C5, 10, 60, 61, 64, 65, 69, 71, 72, 84, 111, 115	21K847070	800 uuf ±10%; 600 v
C11, 12	8D82905G11	0.22 ±10%; 25 v
C59	8C82095G06	0.1 ±10%; 200 v
C63	23D82601A26	25 ±20%; 20 v
C67, 75, 83, 109	21D82428B21	.01 +10-30%; 100 v
C73, 81, 86, 87	23K865137	4.7 ±20%; 25 v
C78	23K865136	15 ±20%; 25 v
C85, 95, 101, 114	23D82601A11	5 +33-10%; 25 v
C102, 116	23D82783B04	100 ±20%; 25 v
C103, 118, 120	21D82428B09	.0047 ±10%; 100 v
C110	21C82187B16	.003 ±10%; 100 v
C117	23D82601A15	3 +150-10%; 100 v
		SEMICONDUCTOR DEVICE, diode: (NOTE)
CR2, 3, 4, 8, 50, 52, 53, 54, 56, 58, 59, 60, 61, 64 thru 69, 75, 76, 79, 80, 84, 85, 86, 88, 89, 92, 93, 95, 96, 97, 113, 114, 125, 126, 127, 129	48C82392B03	silicon
CR57, 62, 63, 77, 112	48C82178A01	germanium
CR82, 94	48C82466H01	silicon
		TRANSISTOR: (NOTE)
Q6, 11, 13, 14, 73, 75, 91	48K869161	germanium; P-N-P; M9161
Q7, 12, 76, 77, 78, 81, 82, 83, 92	48R869160	germanium; P-N-P; M9160
Q74	48K869208	germanium; P-N-P; M9208
Q79, 80, 84, 85, 93	48K869162	germanium; P-N-P; M9162
		RESISTOR, fixed: ±10%; 1/2 w
R15, 29	6R2024	3.9K ±5%
R16, 17, 58, 215, 238, 279, 280, 345	6R6166	1.2K ±5%
R18, 32	6R6428	6.8K
R19	6R6408	100 ±5%
R20, 34, 229, 231, 235, 239, 271, 277, 335, 361	6R6080	4.7K
R21, 207	6S6411	1K ±5%
R31, 333	6400059	1.8K ±5%
R33	6R5645	150 ±5%
R35, 209, 210	6R400459	1.5K ±5%
R36, 43, 236	6R5581	3.3K
R37, 40, 42, 198, 225, 245, 248, 328, 339	6R400490	8.2K ±5%
R38, 41, 191, 228, 246, 247, 332, 337, 362	6R3924	4.7K ±5%
R39, 214, 359	6R2003	3.3K ±5%
R44, 223, 269, 369, 370	6R6048	47K
R45, 254, 272, 366	6R6398	150K
R46	6R6477	15K
R47, 368, 371	6R6031	100K
R199, 256, 334	6R3940	5.6K ±5%
R200, 205, 232, 243	6R2089	1.8K
R201, 203, 213, 331	6R2001	6.8K ±5%
R202, 221, 338	6R2004	8.2K
R206, 219	6R5659	3.9K
R211	6R5673	56 ±5%
R212	6R400058	560 ±5%
R216	6S5652	2.7K ±5%
R217	6S400057	270 ±5%
R218	6R6117	5.6K
R220	6S129681	1.5K ±5%; 1/4 w
R222	6S119172	820 ±5%
R224, 244	6R6373	150
R227, 230	6S6069	2.2K
R234, 242, 249	6R6320	10K
R240, 273, 274	6S6397	22K
R241	6R5577	2.7K
R250, 251, 275, 336, 367	6R6378	56K
R263	6R6434	27K
R270	6S6229	1K
R276	6R6377	470K
R278	6S6040	680
R363	6S400812	470 ±5%
		THERMISTOR:
RT2	6B858402	1K @ 25°C

NOTE:

Replacement transistors and diodes must be ordered by Motorola part number only for optimum performance.


BRN-YEL A+
YEL TO SEIZE TONE SCHMITT TRIGGER
BRN-GRAY TO IDLE TONE SCHMITT TRIGGER
WHT-BRN J
ORG 17
RED-ORG J
WHT-BLU F̄S
RED-GRN W
BRN-GRN 6
WHT-GRN F̄1
RED BLK
RED WHT
GRAY
RED-BRN
GRAY-RED
RED-YEL
WHT-RED
WHT-YEL
BLK-RED
GRAY-YEL
YEL
BLK-BRN
BLU-WHT
GRN-YEL
GRN
RED
BLU
BRN
BLU
WHT-BLK
GRN-ORG
BRN-RED
YEL-GRN
RED
GRAY-GRN
BLK
BRN-BLU
YEL-BRN
C+ K H M P L G M G A- 5 T 9 2 10 19 21 11 T Q 23 15 U P 7 S B- Q
TO Q58 BASE (7-DIGIT OPER.) OR Q54 BASE (5-DIGIT OPER)
TO Q21 COLLECTOR
(NEAR HINGE SIDE)
* FACTORY SELECTED (SEE PARTS LIST)
0L-EEPD-10275-G
0

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R44,223,252, 269	6R6048	47K
R45,122,125, 126,127,130,131, 134,135,138,139, 142, 143, 146, 147, 254, 272	6R6398	150K
R49	6R2039	68
R50	6S6406	22
R55, 323	6R2024	3.9K ±5%
R56, 152, 155, 259, 266, 296, 309, 358	6R6080	4.7K
R57	6R6393	1.2K
R70, 263	6R6434	27K
R71, 157, 186, 188, 281	6R5577	2.7K
R72	6R6410	33K
R153, 156, 173, 181, 262, 283, 285, 289, 290, 291	6R2089	1.8K
R160	6S5652	2.7K ±5%
R163, 340, 356	6R2031	18
R169, 311, 325	6S6229	1K
R170, 171, 175, 177, 189, 190, 295, 301, 302, 347	6R400490	8.2K ±5%
R180, 316, 330	6S6040	680
R182	6R6270	220
R183	6R6117	5.6K
R185	6R6090	470
R194, 196, 322	6R5554	390
R195	6S6291	560
R211	6R5673	56 ±5%
R224, 244	6R5645	150
R257, 313, 317, 320, 327, 354	6R5581	3.3K
R258	6R6410	33K
	or6R6487	39K
	or6R6048	47K
R261, 267, 292, 364	6R6031	100K
R264	6R6477	15K
R265, 293, 294	6R6428	6.8K
	or6R2004	8.2K
	or6R6320	10K
R282	6S6397	22K
R284	6S400812	470 ±5%
R286	6S5672	180 ±5%
R287, 288	6R401006	56K ±5%
R299, 303, 304, 319, 346, 348	6R2001	6.8K ±5%
R300, 306	6R400059	1.8K ±5%
R312, 326	6R6394	12K
R314, 351	6R2062	5.1K ±5%
R318	6R2028	2.2K ±5%
R343	6R121691	120 ±5%
R349, 350	6R400060	2K ±5%
R360	6S128283	110 ±5%
R365	6R129709	470 ±5%; 1/4 w
		THERMISTOR:
RT1	6B865641	300 ohms @ 25°C
		TRANSFORMER, AF:
T1, 3	25C82415G01	pri: GRN, BLK; res 315 ohms max. sec: BLU, RED; res 325 ohms max
T2, 4	25C83413G01	pri: 1, 3; tapped (2) res 104 ohm sec: 4, 5; res 20 ohm ±10%
		SPECIAL ITEMS
		The following list covers capacitors used to make up the required capacitance for "factory-selected" values.
		CAPACITOR, fixed: uuf; ±5% 500 v:
	21K840711	51
	21K850118	100
	21K840047	150
	21K840812	200
	21K859943	250
	21K859944	300
	21K859945	390
	21K845214	510
	21K848236	650
	21K840049	800
		CAPACITOR, fixed: uf; ±10%; 50 v:
	8C82284C01	.001
	8C82284C02	.0015
	8C82284C03	.002
	8C82284C04	.0033
	8C82284C05	.0047
	8C82284C06	.0068
	8C82284C07	.0082
	8C82284C08	.01
	8C82284C09	.015
	8C82284C10	.02
	8C82284C11	.033
	8C82284C12	.047
		RESISTOR, fixed: ±10%; 1/2 w unless stated
	6S6410	33K
	6S6487	39K
	6S6048	47K
	6S6378	56K
	6S6074	68K
	6S5644	82K
	6S6031	100K
	6S5631	120K
	6S6398	150K
	6S6444	180K
	6S6407	220K
	6S6414	270K
	6S5697	560K

NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.

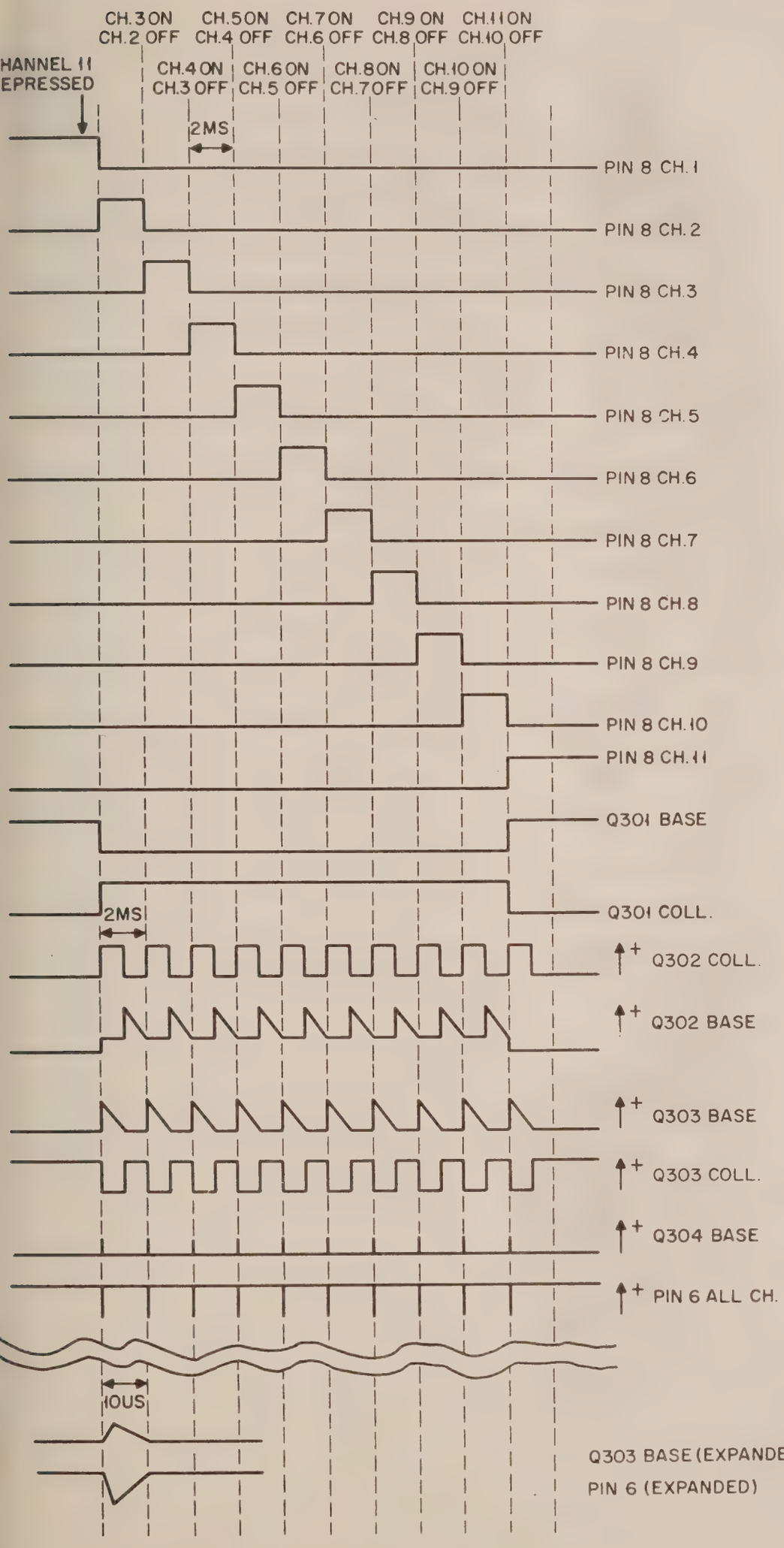
NOTES:

1. UNLESS OTHERWISE STATED CAPACITOR VALUES ARE IN MICROFARADS.
2. UNLESS OTHERWISE STATED RESISTOR VALUES ARE IN OHMS, K = 1000.
3. LEADS ENDING IN LETTER DESIGNATIONS A THROUGH E REFER TO DESTINATIONS IN THE FILTER AND BIAS SUPPLY.
4. LEADS ENDING IN LETTER DESIGNATIONS F THROUGH W REFER TO DESTINATIONS IN OTHER CIRCUITS. LETTERS WITH BARS OVER THEM INDICATE NEGATIVE GOING OUTPUTS. REFER TO THE CIRCUIT ROUTING CHART IN THE INSTRUCTION MANUAL.
5. CIRCLED NUMBERS INDICATE ELECTRICAL CONNECTIONS TO PLUG P1.
6. THE PRINTED CIRCUIT BOARD IS INDICATED IN GREY; THE LAMINATE IS INDICATED IN RED.

EPD-10488-A

SEQUENCE PROGRESSES FROM CH.1 — CH.11

USED IN CAR TELEPHONE
DIAGRAM BOOKLETS
68P81020A75
68P81022A65



Oscillator Module Socket Board
Switching Circuit Timing Chart
For 152-162 MC, ±12 V, 20 W
Motorola Car Telephone Radio Sets
Motorola No. EPD-8742-A
7/10/64-UP

REVISIONS

EPD-10276-P

BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
TLN6815A		RED-ORG LEAD WAS RED-YEL	Q17 COLLECTOR
		RED-BRN LEAD WAS RED-GRAY	Q65 BASE
TLN6815A	R287	WAS 12K	Q95 BASE
	R288	WAS 8.2K	Q94 BASE
	C86, 87	WAS 4.7 uf	Q94 BASE
	CR78	REMOVED	Q95 COLLECTOR
	R365	ADDED	Q95 COLLECTOR
	R179	WAS 10K	Q68 BASE
	CR47	WAS 48C82392B03	PARTS LIST
TLN6815A-1	CR5	WAS 48C82392B03	PARTS LIST
	R51	WAS 3.3K	Q17 COLLECTOR
	R53	WAS 220	Q17 EMITTER
	R52	WAS 5.6K	Q16 EMITTER
	R355	WAS 6.2K	Q107 EMITTER
	R55	WAS 3.9K	Q17 BASE
	R318	WAS 2.7K	Q102 EMITTER
	R139	WAS 8.2K	Q102 EMITTER
	R349, 350	WAS 2.7K	CR119
TLN6815A-1		ADDED REFERENCE TO 5 DIGITOR 7 DIGIT OPERATION	BOTTOM LEFT OF BOARD
TLN6815A-2	R315	WERE 6R6117, 5.6K	PARTS LIST
	R329		
	R314		LEFT OF Q100
	R351		Q101 COLLECTOR
		ADDED MODEL TABLE	
TLN6815A-3	CR70	WAS 48C82178A01	PARTS LIST
TLN6815A-4	C119	ADDED 15 uf IN PARALLEL WITH R174	LEFT CENTER OF BD.
	Q5, 10, 63, 66, 108, 109	WERE 48K869093, M9092 (BLU)	PARTS LIST
TKN6171A-2		ADDED ORG LEAD AT JUNCTION OF R283, Q90 COLL. AND M	LEFT OF BD.
TLN6815A-5	Q4, 8, 9	WERE 48R869186, M9186	PARTS LIST
TLN6815A-6	T2, 4	WERE 25C82283C01	PARTS LIST
	Q72, 104	WERE TYPE M9002	PARTS LIST
	C96	WAS 8D82905G06 0.47 uf ±10%; 25 V	PARTS LIST
	C8, 16, 20	WERE 8D82905G11 0.22 uF, 25 V	
	CR5, 35, 36, 37, 38, 40, 48, 49, 51, 55, 71, 72, 73, 74, 81, 83, 87, 90, 91, 104, 105, 106, 107, 109, 110, 116, 117, 118, 119, 121, 122, 124, 128	WERE 48C82392B03	

MODEL TABLE

MODEL	SUFFIX	DESCRIPTION
TLN6815A	6	OSC. AND DETECTOR BOARD

EPD-13241-C

PREVIOUS REVISIONS AND PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

Oscillator and Detector Circuit Board Detail
Model TLN6815A Used in IMTS Control Terminal
Motorola No. EPD-10276-P (SMR-867F)
7/9/71-

PARTS LIST

TLN6815A Oscillator & Detector Board PL-697-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uf: unl stated
C1, 2, 6, 7, 94, 99, 100		(factory selected; see "SPECIAL ITEMS")
C3, 93, 98	8C82095G04	.068 ±10%; 200 v
C4, 9, 86, 87	23D82783B08	1 ±20%; 35 v
C8, 16, 20	8D82905G32	0.22 ±10%; 50 v
C13, 77, 119	23K865136	15 ±20%; 25 v
C14, 15, 79, 80 82, 88, 90, 104, 107, 108	21K847070	800 uuf ±10%; 600 v
C21, 70	8C82905G14	.01 ±10%; 100 v
C76	23D82783B04	100 ±20%; 25 v
C81	23K865137	4.7 ±20%; 25 v
C92, 97	23D82601A04	2 +250-10%; 25 v
C96	8D82905G33	0.47 ±20% 50 v
C106	23C82077C05	300 +150-10%; 20 v
C112, 113	8C82095G06	0.1 ±10%; 200 v
		SEMICONDUCTOR DEVICE, diode: (NOTE)
CR1, 34, 47, 101, 102, 108, 111, 112, 115, 120, 123	48C82178A01	germanium
CR5, 35, 36, 37, 38, 40, 48, 49, 51, 55, 71, 72, 73, 74, 81, 83, 87, 90, 91, 104, 105, 106, 107, 109, 110, 116, 117, 118, 119, 121, 122, 124, 128	48C83654H01	silicon
CR41	48C82095C03	silicon
CR70	48C82466H01	silicon
		COIL, AF:
L1, 2	24V80902A98	tuning; (factory-adjusted)
L3	25B82815D01	choke; 2.5 mh
		TRANSISTOR: (NOTE)
Q1, 2	48R869072	P-N-P; M9072
Q3, 69	48R869092	N-P-N; M9092
Q4, 9	48R869377	N-P-N; M9377
Q5, 10, 63, 66, 108, 109	48R869093	N-P-N; M9093
Q8	48R869378	N-P-N; M9378
Q15, 16, 17, 18 23, 60, 64, 67, 87, 89, 90, 96, 99, 100, 101, 105, 106	48R869160	P-N-P; M9160
Q61, 62, 65, 88, 94, 95, 97, 98, 102, 103, 107	48K869161	P-N-P; M9161
Q68	48R869002	N-P-N; M9002
Q70	48K869162	P-N-P; M9162
Q71	48R869187	N-P-N; M9187
Q72, 104	48K869096	N-P-N; M9096
		RESISTOR, fixed: ±10%; 1/2 w; unl stated
R1, 6, 51	6R2003	3.3K ±5%
R2, 5, 14, 26, 28	6R400058	560 ±5%
R3, 7, 342	6S6411	1K ±5%
R4, 53	6R2002	220 ±5%
R8, 24, 48	6R6428	6.8K
R9, 25, 54, 151, 154, 193, 260, 268, 298, 307	6R2004	8.2K
R10, 52, 161, 162, 315, 329, 355	6R3940	5.6K ±5%
R11, 159, 172, 174, 192, 297, 305, 321, 324	6R3924	4.7K ±5%
R12, 176, 179, 184, 308, 352	6S6069	2.2K
R13, 27	6R400056	47 ±5%
R22, 30, 73, 158, 164, 187, 197, 310, 344, 353	6R6320	10K
R23	6R5556	10K ±5%
R44, 223, 252, 269	6R6048	47K
R45, 122, 123, 126, 127, 130, 131, 134, 135, 138, 139, 142, 143, 146, 147, 254, 272	6R6398	100K
R49	6R2039	68
R50	6S6407	22
R55, 323	6R2024	3.9K ±5%
R56, 152, 155, 259, 266, 296, 309, 358	6R6080	4.7K
R57	6R6393	1.2K
R70, 263	6R6434	27K
R71, 157, 186, 188, 281	6R5577	2.7K
R72	6R6410	33K
R153, 156, 173, 181, 262, 283, 285, 289, 290, 291	6R2089	1.8K
R160	6S5652	2.7K ±5%
R163, 340, 356	6R2031	18
R169, 311, 325	6S6229	1K
R170, 171, 175, 177, 189, 190, 295, 301, 302, 347	6R400490	8.2K ±5%
R180, 316, 330	6S6040	680
R182	6R6270	220
R183	6R6117	5.6K
R185	6R6090	470
R194, 196, 322	6R5554	390
R195	6S6291	560
R211	6R5673	56 ±5%
R224, 244	6R5645	150
R257, 313, 317, 320, 327, 354	6R5581	3.3K
R258	6R6410 or6R6487 or6R6048	33K 39K 47K
R261, 267, 292, 364	6R6031	100K
R264	6R6477	15K
R265, 293, 294	6R6428 or6R2004 or6R6320	6.8K 8.2K 10K
R282	6S6397	22K
R284	6S400812	470 ±5%
R286	6S5672	180 ±5%
R287, 288	6R401006	56K ±5%
R299, 303, 304, 319, 346, 348	6R2001	6.8K ±5%
R300, 306	6R400059	1.8K ±5%
R312, 326	6R6394	12K
R314, 351	6R2062	5.1K ±5%
R318	6R2028	2.2K ±5%
R343	6R121691	120 ±5%
R349, 350	6R400060	2K ±5%
R360	6S128283	110 ±5%
R365	6R129709	470 ±5%; 1/4 w
		THERMISTOR:
RT1	6B865641	300 ohms @ 25°C
		TRANSFORMER, AF:
T1, 3	25C82415G01	pri: GRN, BLK; res 315 ohms max. sec: BLU, RED; res 325 ohms max
T2, 4	25C83413G01	pri: 1, 3; tapped (2) res 104 ohm sec: 4, 5; res 20 ohm ±10%
		SPECIAL ITEMS The following list covers capacitors used to make up the required capacitance for "factory-selected" values.
		CAPACITOR, fixed: uuf; ±5% 500 v:
	21K840711	51
	21K850118	100
	21K840047	150
	21K840812	200
	21K859943	250
	21K859944	300
	21K859945	390
	21K845214	510
	21K848236	650
	21K840049	800
		CAPACITOR, fixed: uf; ±10%; 200 v:
	8C82284C01	.001
	8C82284C02	.0015
	8C82284C03	.002
	8C82284C04	.0033
	8C82284C05	.0047
	8C82284C06	.0068
	8C82284C07	.0082
	8C82284C08	.01
	8C82284C09	.015
	8C82284C10	.02
	8C82284C11	.033
	8C82284C12	.047
		RESISTOR, fixed: ±10%; 1/2 w unless stated
	6S6410	33K
	6S6487	39K
	6S6048	47K
	6S6378	56K
	6S6074	68K
	6S5644	82K
	6S6031	100K
	6S5631	120K
	6S6398	150K
	6S6444	180K
	6S6407	220K
	6S6414	270K
	6S5697	560K

NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.

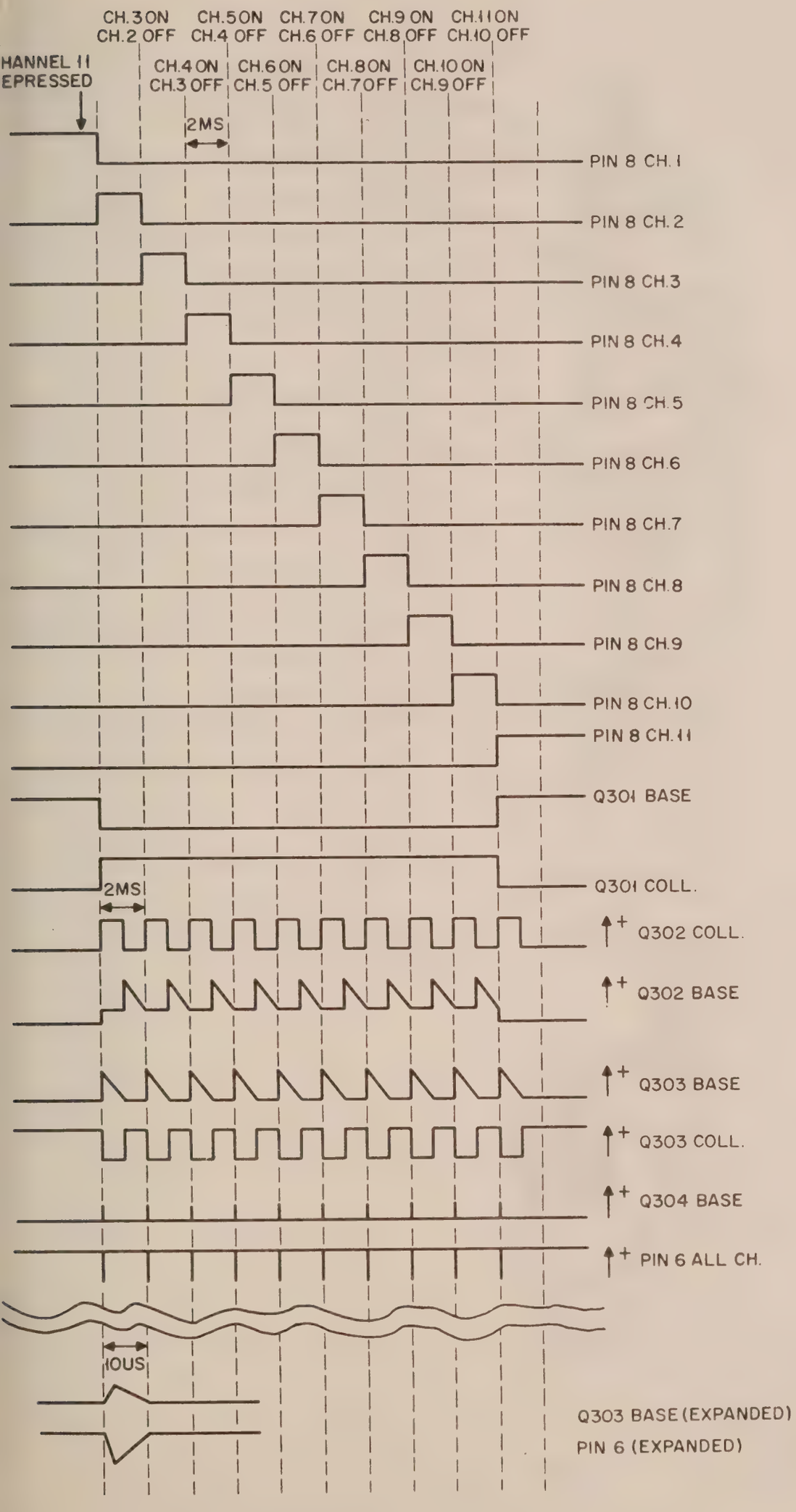
NOTES:

1. UNLESS OTHERWISE STATED CAPACITOR VALUES ARE IN MICROFARADS.
2. UNLESS OTHERWISE STATED RESISTOR VALUES ARE IN OHMS. K = 1000
3. LEADS ENDING IN LETTER DESIGNATIONS A THROUGH E REFER TO DESTINATIONS IN THE FILTER AND BIAS SUPPLY.
4. LEADS ENDING IN LETTER DESIGNATIONS F THROUGH W REFER TO DESTINATIONS IN OTHER CIRCUITS. LETTERS WITH BARS OVER THEM INDICATE NEGATIVE GOING OUTPUTS. REFER TO THE CIRCUIT ROUTING CHART IN THE INSTRUCTION MANUAL.
5. CIRCLED NUMBERS INDICATE ELECTRICAL CONNECTIONS TO PLUG P1
6. THE PRINTED CIRCUIT BOARD IS INDICATED IN GREY: THE LAMINATE IS INDICATED IN RED.

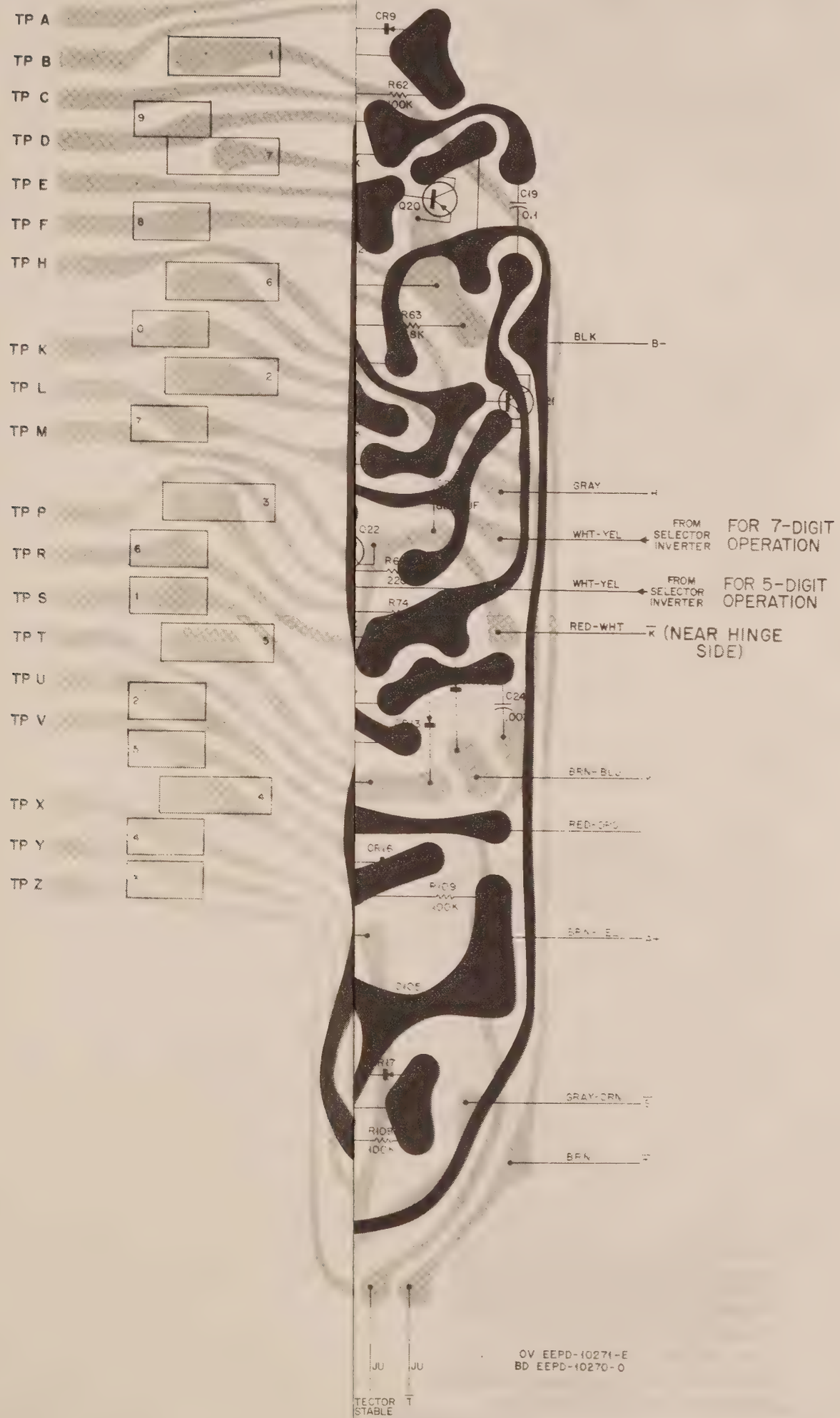
EPD-10486-

SEQUENCE PROGRESSES FROM CH.1 — CH.11

USED IN CAR TELEPHONE
DIAGRAM BOOKLETS
68P81020A75
68P81022A65



Oscillator Module Socket Board
Switching Circuit Timing Chart
For 152-162 MC, ±12 V, 20 W
Motorola Car Telephone Radio Sets
Motorola No. EPD-8742-A
7/10/64-UP


TP A
TP B
TP C
TP D
TP E
TP F
TP H
TP K
TP L
TP M
TP P
TP R
TP S
TP T
TP U
TP V
TP X
TP Y
TP Z
CR9
R62
100K
Q20
C19
0.1
R63
BLK
B-
GRAY
H
Q22
WHT-YEL
FROM SELECTOR INVERTER
FOR 7-DIGIT OPERATION
WHT-YEL
FROM SELECTOR INVERTER
FOR 5-DIGIT OPERATION
R74
RED-WHT
K (NEAR HINGE SIDE)
C24
BRN-BLK
RED-ORG
CR16
R109
400K
GRAY-GRN
BRN
OV EEPD-10271-E
BD EEPD-10270-0

TP A
TP B
TP C
TP D
TP E
TP F
TP H
TP K
TP L
TP M
TP P
TP R
TP S
TP T
TP U
TP V
TP X
TP Y
TP Z

BLK — B-

GRAY — H

WHT-YEL — FROM SELECTOR INVERTER — FOR 7-DIGIT OPERATION

WHT-YEL — FROM SELECTOR INVERTER — FOR 5-DIGIT OPERATION

RED-WHT — $\overline{K}$ (NEAR HINGE SIDE)

BRN-B...

GRAY-GRN

BRN

RED-GRN
GRN-RED
BLK-RED
YEL-BRN
YEL-GRN

W W B $\overline{E}$ E G $\overline{F}$ F $\overline{G}$ G A+ B- DETECTOR BISTABLE $\overline{T}$

OV EEPD-1027C-E
BD EEPD-1027C-0



IOUS REVISIONS LISTED
ACK OF THIS DIAGRAM

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ol Head for 152-162 MC,
±12 V DC Motorola Car
hone Radio Set
atic Diagram 63D81021A77-O3 (T-2663B)
/67-

REVISIONS

DIAG. ISSUE	BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
A	TLN6814A		RED-ORG LEAD WAS RED-YEL	Q24 BASE
B	TLN6814A	R67	WAS 4.7K	Q21 BASE
C	TLN6814A-1	C105	WAS 23D82601A25	PARTS LIST
D	TLN6814A-2		ADDED 5 DIGIT OPERATION LEAD	Q54 BASE
E			ADDED MODEL TABLE	
F	TLN6814A-3	Q20, 21	WERE 48R869160: M9160	INTERDIGIT TIMER
		R63	WAS 6R3940, 5.6K ±5%	Q21 EMITTER
		R67	WAS 6R2024, 3.9K ±5%	Q21 BASE

NOTES:

1. UNLESS OTHERWISE STATED CAPACITOR VALUES ARE IN MICROFARADS.
2. UNLESS OTHERWISE STATED RESISTOR VALUES ARE IN OHMS, K = 1000.
3. LEADS ENDING IN LETTER DESIGNATIONS A THROUGH E REFER TO DESTINATIONS IN THE FILTER AND BIAS SUPPLY.
4. LEADS ENDING IN LETTER DESIGNATIONS F THROUGH W REFER TO DESTINATIONS IN OTHER CIRCUITS. LETTERS WITH BARS OVER THEM INDICATE NEGATIVE GOING OUTPUTS. REFER TO THE CIRCUIT ROUTING CHART IN THE INSTRUCTION MANUAL.
5. CIRCLED NUMBERS INDICATE ELECTRICAL CONNECTIONS TO PLUG P1.
6. * ASTERISK DENOTES FACTORY SELECTED COMPONENT.
7. THE PRINTED CIRCUIT BOARD IS INDICATED IN GREY; THE LAMINATE IS INDICATED IN RED.

EPD-10487-A

MODEL TABLE

MODEL	SUFFIX	DESCRIPTION
TLN6814A	3	SELECTOR CIRCUIT BOARD

EPD-13239-A

PREVIOUS REVISIONS SHOWN ON BACK OF THIS DIAGRAM

Selector Circuit Board Detail
Model TLN6814A used in
152-162 MC, 20 W, ±12 V DC
Motorola Car Telephone Radio Set
And IMTS Control Terminal
Motorola No. EPD-10272-G (T-2880A)
5/15/68-

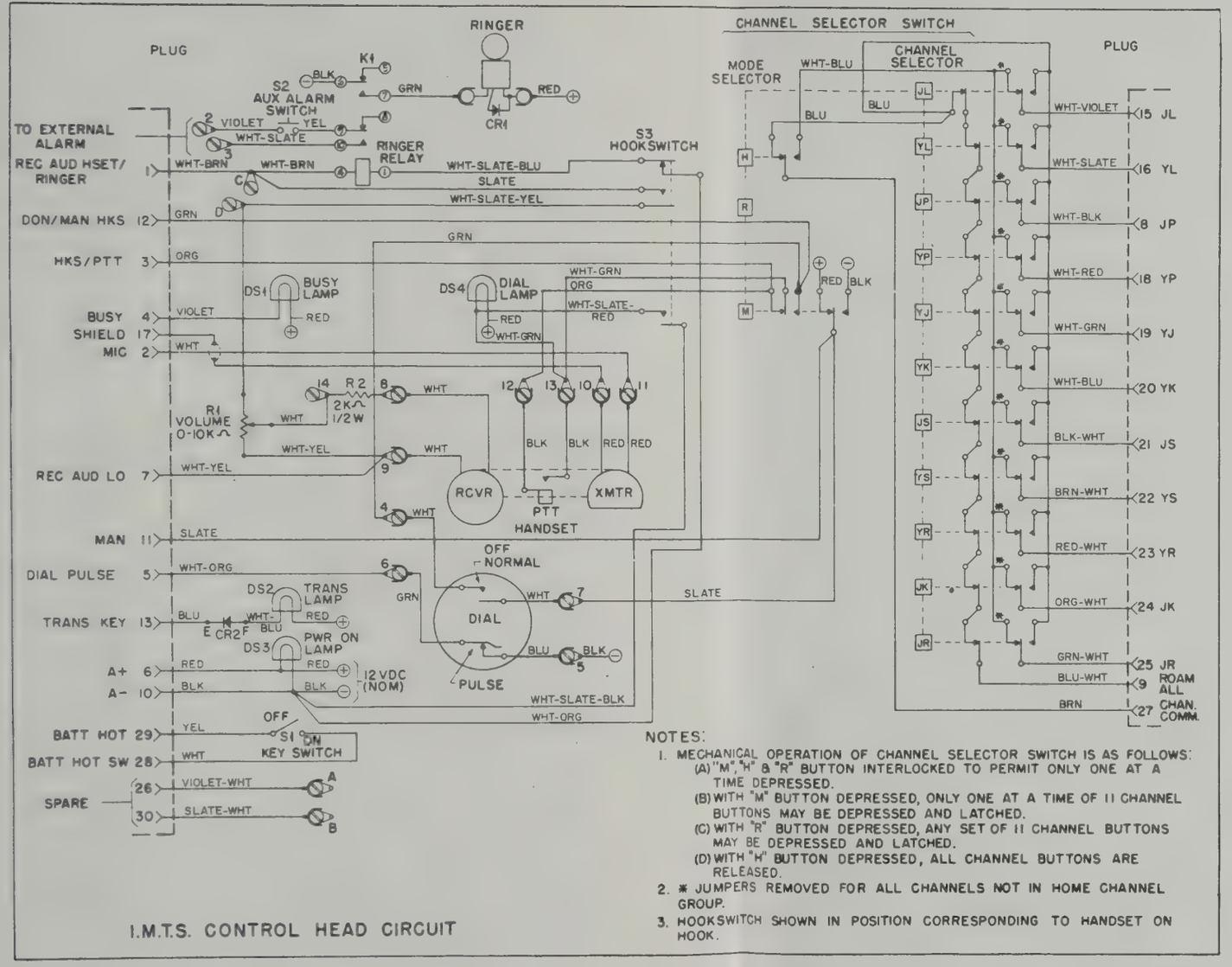
PARTS LIST for Diagram EPD-10272-G

TLN6814A Selector Board Kit

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uf; unl stated:
C17	23K865136	15 ±20%; 25 v
C18, 39	8D82905G11	0.22 ±10%; 25 v
C22, 23	21K847070	800 uuf ±10%; 600 v
C24, 37, 40	21C82187B16	.003 ±10%; 100 v
C25, 27 thru 36, 38, 43, 45, 47, 49, 51, 53, 55, 56	8C82095G04	.068 ±10%; 200 v
C105	23D82783B04	100 ±20%; 25 v
		SEMICONDUCTOR DEVICE, diode: (NOTE)
CR6, 9 thru 33, 39, 42 thru 46, 103	48C82392B03	silicon
		TRANSISTOR: (NOTE)
Q19, 22, 24, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 44, 45, 47, 49, 51, 53, 55, 57, 59	48R869160	germanium; P-N-P; M9160
Q26, 28, 30, 32, 34, 36, 38, 40, 42, 46, 48, 50, 52, 54, 56, 58	48R869092	germanium; N-P-N; M9092
Q20	48R869169	germanium; P-N-P; M9161
Q21	48R869326	silicon; P-N-P; M9326
		RESISTOR, fixed: ±10%; 1/2 w; unl stated
R59, 76	6R6487	39K
R60	6S6069	2.2K
R61	6S6406	22
R62, 66, 105, 106, 107, 108, 109, 114, 115, 120, 165, 167	6R6031	100K
R63, 67, 80, 116	6R2001	6.8K ±5%
R64	6R2002	220 ±5%
R65	6R2003	3.3K ±5%
R68, 357	6R6080	4.7K
R69	6R2028	2.2K ±5%
R74	6R2004	8.2K
R75, 82	6R6378	56K
R77	6R6428	6.8K
R79, 113	6D82672B07	47.5 ±1%
R81, 117	6R400459	1.5K ±5%
R83, 119	6R3924	4.7K ±5%
R84, 85, 87, 89, 91, 93, 95, 97, 99, 101, 104, 118, 121, 125, 129, 133, 137, 141, 145, 150	6R6411	1K ±5%
R86, 88, 90, 92, 94, 96, 98, 100, 102, 124, 128, 132, 136, 140, 144, 148	6R400804	390 ±5%
R103, 149	6C82810D13	2.37K ±1%
R110	6R5644	82K
R122, 123, 126, 127, 130, 131, 135, 138, 139, 142, 143, 146, 147	6R6398	150K
R168	6S6407	220K
R341	6S2085	39

NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.



I.M.T.S. CONTROL HEAD CIRCUIT

NOTES:

1. MECHANICAL OPERATION OF CHANNEL SELECTOR SWITCH IS AS FOLLOWS:
   (A) "M", "H" & "R" BUTTON INTERLOCKED TO PERMIT ONLY ONE AT A TIME DEPRESSED.
   (B) WITH "M" BUTTON DEPRESSED, ONLY ONE AT A TIME OF 11 CHANNEL BUTTONS MAY BE DEPRESSED AND LATCHED.
   (C) WITH "R" BUTTON DEPRESSED, ANY SET OF 11 CHANNEL BUTTONS MAY BE DEPRESSED AND LATCHED.
   (D) WITH "H" BUTTON DEPRESSED, ALL CHANNEL BUTTONS ARE RELEASED.
2. * JUMPERS REMOVED FOR ALL CHANNELS NOT IN HOME CHANNEL GROUP.
3. HOOKSWITCH SHOWN IN POSITION CORRESPONDING TO HANDSET ON HOOK.

DIAGRAM NO. 63D81021A77-03

PREVIOUS REVISIONS LISTED
ON BACK OF THIS DIAGRAM

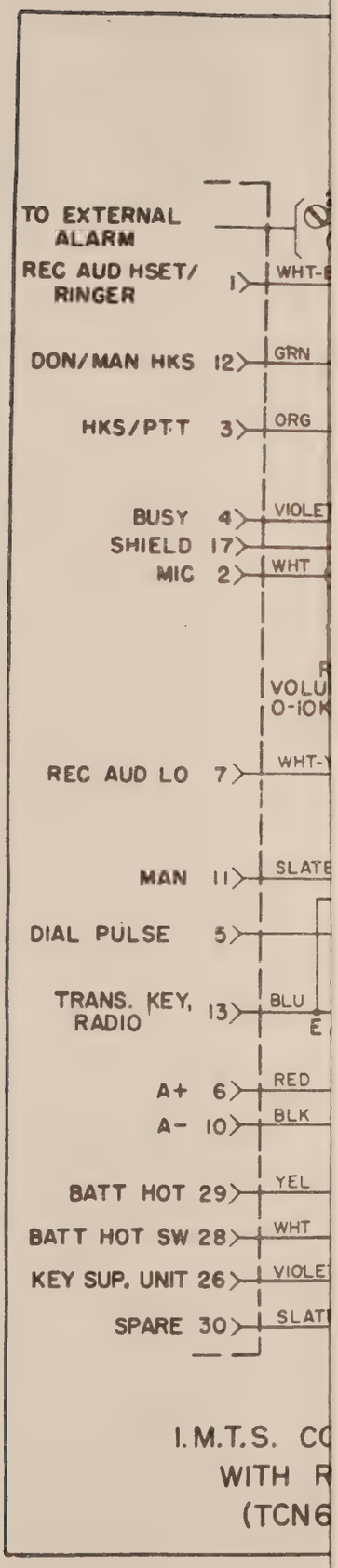
Control Head for 152-162 MC,
20 W, ±12 V DC Motorola Car
Telephone Radio Set
Schematic Diagram 63D81021A77-O3 (T-2663B)
10/20/67-

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	50D82904E06	HANDSET ASS'Y, incl. CORD, coil TURQUOISE (Western Electric)
	50D83449A01	HANDSET ASS'Y, incl. CORD, coiled: BLACK (Motorola)
	50D83449A02	HANDSET ASS'Y; incl. CORD, coiled: WHITE (Motorola)
	50D83449A03	HANDSET ASS'Y; incl. CORD, coiled: RED (Motorola)
	50D83449A04	HANDSET ASS'Y; incl. CORD, coiled: BLUE (Motorola)
	50D83449A05	HANDSET ASS'Y; incl. CORD, coiled: BEIGE (Motorola)
	50D83449A06	HANDSET ASS'Y; incl. CORD, coiled: TURQUOISE (Motorola)
	50D83449A07	HANDSET ASS'Y; incl. CORD, coiled: PINK (Motorola)
	55P83928C37	HANDLE, BLACK
	55P83928C38	HANDLE, RED
	55P83928C39	HANDLE, ROSE PINK
	55P83928C40	HANDLE, AQUA BLUE
	55P83928C41	HANDLE, LIGHT BEIGE
	55P83928C42	HANDLE, WHITE
	55P83928C43	HANDLE, TURQUOISE
	7P83471A01	BRACKET, mounting
	40P83471A03	SWITCH, aux. pushbutton
	40P83471A04	SWITCH, channel selector
	80P83471A05	RELAY, ring
	40P83471A07	SWITCH, lock (W/2 KEYS)
	18P83471A08	POTENTIOMETER
	40P83471A10	CRADLE SWITCH ASS'Y
	33P83471A13	NAMEPLATE ASS'Y, "Radio telephone"
	38P83471A16	PUSHBUTTON ASS'Y (JL)
	38P83471A17	PUSHBUTTON ASS'Y (YL)
	38P83471A18	PUSHBUTTON ASS'Y (JP)
	38P83471A19	PUSHBUTTON ASS'Y (YP)
	38P83471A20	PUSHBUTTON ASS'Y (YJ)
	38P83471A21	PUSHBUTTON ASS'Y (YK)
	38P83471A22	PUSHBUTTON ASS'Y (JS)
	38P83471A23	PUSHBUTTON ASS'Y (YS)
	38P83471A24	PUSHBUTTON ASS'Y (YR)
	38P83471A25	PUSHBUTTON ASS'Y (JK)
	38P83471A26	PUSHBUTTON ASS'Y (JR)
	38P83471A27	PUSHBUTTON ASS'Y (H)
	38P83471A28	PUSHBUTTON ASS'Y (M)
	38P83471A29	PUSHBUTTON ASS'Y (R)
	38P83471A30	PUSHBUTTON ASS'Y (Aux)
	38P83471A31	PUSHBUTTON ASS'Y (No Designation)
	42P83471A33	CLAMP (LH)
	42P83471A34	CLAMP (RH)
	41P83471A35	SPRINGS, clamp
	47P83471A36	PIVOT PIN, clamp
	45P83471A37	ACTUATOR ARM ASS'Y
	41P83471A38	SPRING, actuator arm
	41P83471A39	SPRING, large (for Cradle Switch)
	7P83471A40	CRADLE SWITCH BRACKET ASS'Y
	9P83471A41	RELAY SOCKET ASS'Y (Ring)
	43P83471A42	RETAINER, relay ring
	43P83471A43	SPACER, mounting (threaded hex)
	43P83471A44	TERMINAL BOARD ASS'Y (14 cont. - diode & resistor)
	31P83471A45	TERMINAL BOARD ASS'Y (4 cont.)
	43P83471A46	SPACER, term. board
	7P83471A47	BRACKET, term. board mounting (LH)
	7P83471A48	BRACKET, term. board mounting (RH)
	5P83471A49	GROMMET
	5P83471A50	GROMMET (for RH Mounting Bracket)
	2P83471A51	SPEEDNUT, "U" type
	32P83471A52	GASKET, dial
	46P83471A53	FINGER STOP, dial
	26P83471A54	SHIELD, light
	7P83471A55	BRACKET, dial light mounting
	7P83471A56	BRACKET, lamp mounting (Trans - Busy)
	9P83471A57	LAMP SOCKET ASS'Y (on-off)
	65P83471A58	LAMP (Minature Bay. Base)
	7P83471A59	MOUNTING BRACKET ASS'Y (Base Plate) RH
	7P83471A60	MOUNTING BRACKET ASS'Y

REFERENCE SYMBOL	MOTOROLA PART NO.	ESCRIPTION
	59P83471A62	TRANSMITTER ASS'Y (Handset)
	59P83471A63	RECEIVER ASS'Y (Handset)
	13P83471A66	ESCUTCHEON (Handset)
	41P83471A68	RESTORING SPRING (Handset)
	40P83471A69	SWITCH ASS'Y (Handset)
	59P83471A70	MEMBRANE ASS'Y (Handset
	3P83471A71	CAP SCREW, flat head (Handset)
	80P83471A72	BELL ASS'Y (Incl. Mounting Screws and Diode)
	80P83471A73	BELL
	33P83471A75	NAMEPLATE ASS'Y (Motorola)
	61P83471A76	LENS (Transmit)
	61P83471A77	LENS (Busy)
	65P83471A78	EDGE LIGHT
	3P83471A80	SCREW (Top of Front Shell)
	3P83471A81	SCREW (Bottom of Front Shell)
	3P83471A82	SCREW (Rear Shell)
	42P83471A83	TIE (Nylon)
	4P83471A87	WASHER, insulating

NOTE:

Replacement diodes must be ordered by Motorola part number only for optimum performance.



PREVIOUS REVISIONS LISTED
ON BACK OF THIS DIAGRAM

Control Head for 152-162 MC
20 W, ±12 V DC Motorola Car
Telephone Radio Set
Schematic Diagram
Motorola No. 63D81021A87-O4 (T-2663C)
10/20/67-

REVISIONS

DIAG. ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
01		NON-REF	ADDED: - 7P83471A01 BRACKET, MTG. 42P83471A02 RING, LOCKOUT 80P83471A06 BELL 33P83471A11 NAMEPLATE 54P83471A12 STRIP, NUMBER CARD	PARTS LIST
02		NON-REF	ADDED ADDITIONAL PARTS	PARTS LIST
03		NON-REF	PART NUMBERS 50D82904E01, E03, E04, E05, E02 AND E06 WERE 50P83928C30, C31, C32, C33, C34, C35, C36 RESPECTIVELY.	PARTS LIST
			REMOVED 48P83471A86 DIODE	

PARTS LIST for Schematic Diagram 63D81021A77-O3

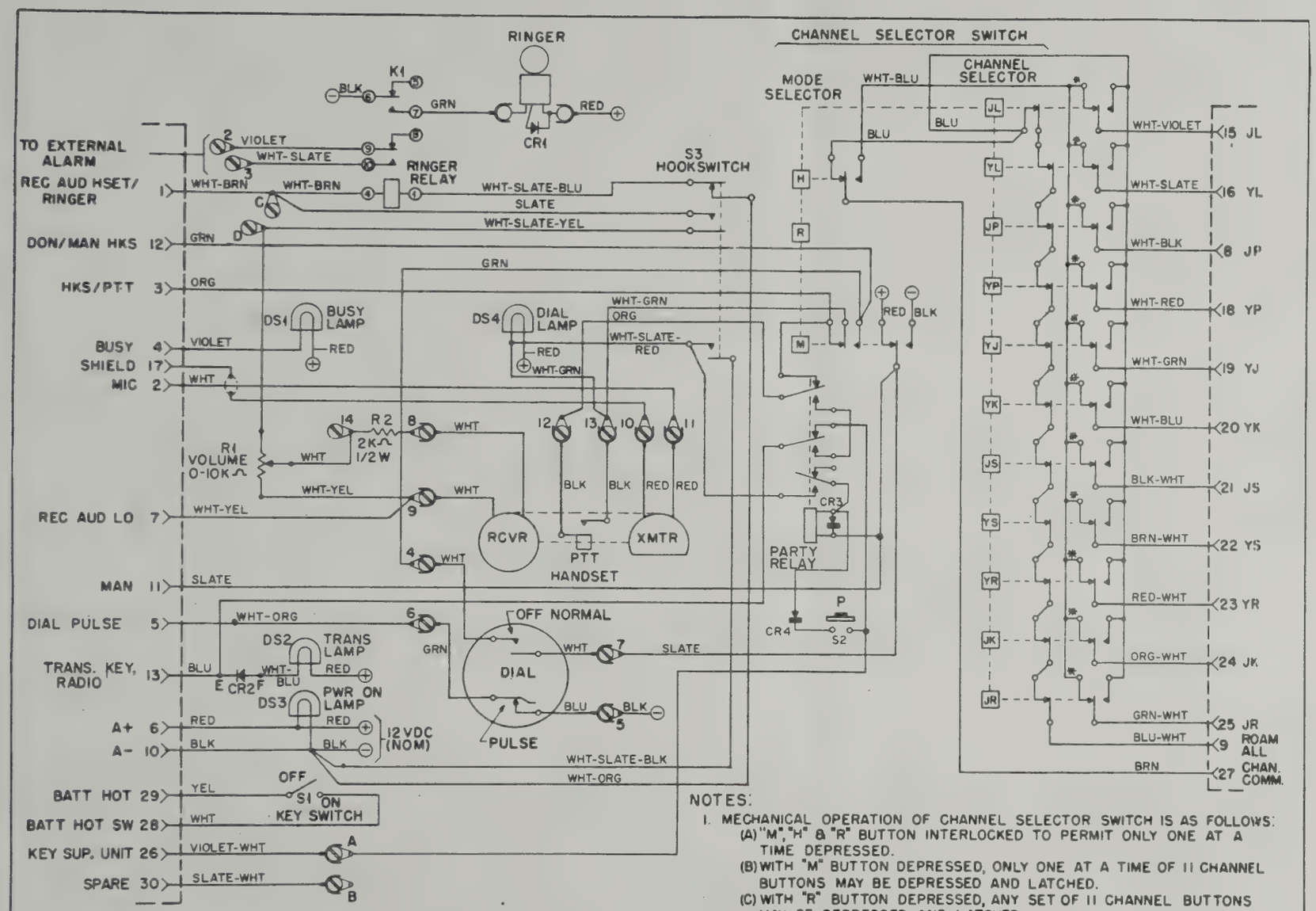
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		SEMICONDUCTOR DEVICE, diode: SEE NOTE
CR1, 2	48C82392B03	silicon
		LAMP, incandescent:
DS1, 2, 3, 4	65R122665	12-16 volt, 1/10 ampere
		RELAY, armature:
K1	80P83471A05	12 volt
		RESISTOR, 1/2 watt:
R1	18P83471A08	var; 0-10K; ±20% (min)
R2	6R400060	fixed: 2K; ±5%
		SWITCH:
S1	40P83471A07	key, spst
S2	40P83471A03	pushbutton, dpst
S3	40P83471A10	cradle assembly
	NON-REFERENCED ITEMS	
	30P83471A09	CABLE assy. with connector
	7P83471A01	BRACKET, mounting
	42P83471A02	RING, lockout
	80P83471A06	BELL
	33P83471A11	NAMEPLATE
	54P83471A12	STRIP, number card
	30P83928C01	CORD, coiled, 6 cond. BLACK
	30P83928C02	CORD, coiled, 6 cond. RED
	30P83928C03	CORE, coiled, 6 cond. ROSE PINK
	30P83928C04	CORD, coiled, 6 cond. AQUA BLUE
	30P83928C05	CORD, coiled, 6 cond. LIGHT BEIGE
	30P83928C06	CORD, coiled, 6 cond. WHITE
	30P83928C07	CORD, coiled, 6 cond. TURQUOISE
	15P83928C08	CAP, handset (Xmtr.) BLACK
	15P83928C09	CAP, handset (Xmtr.) RED
	15P83928C10	CAP, handset (Xmtr.) ROSE PINK
	15P83928C11	CAP, handset (Xmtr.) AQUA BLUE
	15P83928C12	CAP, handset (Xmtr.) LIGHT BEIGE
	15P83928C13	CAP, handset (Xmtr.) WHITE
	15P83928C14	CAP, handset (Xmtr.) TURQUOISE
	15P83928C15	CAP, handset (Rcvr.) BLACK
	15P83928C16	CAP, handset (Rcvr.) RED
	15P83928C17	CAP, handset (Rcvr.) ROSE PINK
	15P83928C18	CAP, handset (Rcvr.) AQUA BLUE
	15P83928C19	CAP, handset (Rcvr.) LIGHT BEIGE
	15P83928C20	CAP, handset (Rcvr.) WHITE
	15P83928C21	CAP, handset (Rcvr.) TURQUOISE
	47P83928C22	PLUNGER BAR, handset (Motorola) BLACK
	47P83928C23	PLUNGER BAR, handset RED
	47P83928C24	PLUNGER BAR, handset ROSE PINK
	47P83928C25	PLUNGER BAR, handset AQUA BLUE
	47P83928C26	PLUNGER BAR, handset LIGHT BEIGE
	47P83928C27	PLUNGER BAR, handset WHITE
	47P83928C28	PLUNGER BAR, handset TURQUOISE
	55P83928C29	KEY (only) (for 40P83471A07)
	50D82904E01	HANDSET ASS'Y, incl. CORD, coil BLACK (Western Electric)
	50D82904E03	HANDSET ASS'Y, incl. CORD, coil RED (Western Electric)
	50D82904E07	HANDSET ASS'Y, incl. CORD, coil ROSE PINK (Western Electric)
	50D82904E04	HANDSET ASS'Y, incl. CORD, coil AQUA BLUE (Western Electric)
	50D82904E05	HANDSET ASS'Y, incl. CORD, coil LIGHT BEIGE (Western Electric)
	50D82904E02	HANDSET ASS'Y, incl. CORD, coil WHITE (Western Electric)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	50D82904E06	HANDSET ASS'Y, incl. CORD, coil TURQUOISE (Western Electric)
	50D83449A01	HANDSET ASS'Y, incl. CORD, coiled: BLACK (Motorola)
	50D83449A02	HANDSET ASS'Y; incl. CORD, coiled: WHITE (Motorola)
	50D83449A03	HANDSET ASS'Y; incl. CORD, coiled: RED (Motorola)
	50D83449A04	HANDSET ASS'Y; incl. CORD, coiled: BLUE (Motorola)
	50D83449A05	HANDSET ASS'Y; incl. CORD, coiled: BEIGE (Motorola)
	50D83449A06	HANDSET ASS'Y; incl. CORD, coiled: TURQUOISE (Motorola)
	50D83449A07	HANDSET ASS'Y; incl. CORD, coiled: PINK (Motorola)
	55P83928C37	HANDLE, BLACK
	55P83928C38	HANDLE, RED
	55P83928C39	HANDLE, ROSE PINK
	55P83928C40	HANDLE, AQUA BLUE
	55P83928C41	HANDLE, LIGHT BEIGE
	55P83928C42	HANDLE, WHITE
	55P83928C43	HANDLE, TURQUOISE
	7P83471A01	BRACKET, mounting
	40P83471A03	SWITCH, aux. pushbutton
	40P83471A04	SWITCH, channel selector
	80P83471A05	RELAY, ring
	40P83471A07	SWITCH, lock (W/2 KEYS)
	18P83471A08	POTENTIOMETER
	40P83471A10	CRADLE SWITCH ASS'Y
	33P83471A13	NAMEPLATE ASS'Y, "Radio telephone"
	38P83471A16	PUSHBUTTON ASS'Y (JL)
	38P83471A17	PUSHBUTTON ASS'Y (YL)
	38P83471A18	PUSHBUTTON ASS'Y (JP)
	38P83471A19	PUSHBUTTON ASS'Y (YP)
	38P83471A20	PUSHBUTTON ASS'Y (YJ)
	38P83471A21	PUSHBUTTON ASS'Y (YK)
	38P83471A22	PUSHBUTTON ASS'Y (JS)
	38P83471A23	PUSHBUTTON ASS'Y (YS)
	38P83471A24	PUSHBUTTON ASS'Y (YR)
	38P83471A25	PUSHBUTTON ASS'Y (JK)
	38P83471A26	PUSHBUTTON ASS'Y (JR)
	38P83471A27	PUSHBUTTON ASS'Y (H)
	38P83471A28	PUSHBUTTON ASS'Y (M)
	38P83471A29	PUSHBUTTON ASS'Y (R)
	38P83471A30	PUSHBUTTON ASS'Y (Aux)
	38P83471A31	PUSHBUTTON ASS'Y (No Designation)
	42P83471A33	CLAMP (LH)
	42P83471A34	CLAMP (RH)
	41P83471A35	SPRINGS, clamp
	47P83471A36	PIVOT PIN, clamp
	45P83471A37	ACTUATOR ARM ASS'Y
	41P83471A38	SPRING, actuator arm
	41P83471A39	SPRING, large (for Cradle Switch)
	7P83471A40	CRADLE SWITCH BRACKET ASS'Y
	9P83471A41	RELAY SOCKET ASS'Y (Ring)
	43P83471A42	RETAINER, relay ring
	43P83471A43	SPACER, mounting (threaded hex)
	43P83471A44	TERMINAL BOARD ASS'Y (14 cont. - diode & resistor)
	31P83471A45	TERMINAL BOARD ASS'Y (4 cont.)
	43P83471A46	SPACER, term. board
	7P83471A47	BRACKET, term. board mounting (LH)
	7P83471A48	BRACKET, term. board mounting (RH)
	5P83471A49	GROMMET
	5P83471A50	GROMMET (for RH Mounting Bracket)
	2P83471A51	SPEEDNUT, "U" type
	32P83471A52	GASKET, dial
	46P83471A53	FINGER STOP, dial
	26P83471A54	SHIELD, light
	7P83471A55	BRACKET, dial light mounting
	7P83471A56	BRACKET, lamp mounting (Trans - Busy)
	9P83471A57	LAMP SOCKET ASS'Y (on-off)
	65P83471A58	LAMP (Minature Bay. Base)
	7P83471A59	MOUNTING BRACKET ASS'Y (Base Plate) RH
	7P83471A60	MOUNTING BRACKET ASS'Y

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	54P83471A62	TRANSMITTER ASS'Y (Handset)
	54P83471A63	RECEIVER ASS'Y (Handset)
	13P83471A66	ESCUTCHEON (Handset)
	41P83471A68	RESTORING SPRING (Handset)
	[illegible]	SWITCH ASS'Y (Handset)
	54P83471A70	MEMBRANE ASS'Y (Handset
	3P83471A71	CAP SCREW, flat head (Handset)
	80P83471A72	BELL ASS'Y (Incl. Mounting Screws and Diode)
	80P83471A73	BELL
	33P83471A75	NAMEPLATE ASS'Y (Motorola
	61P83471A76	LENS (Transmit)
	61P83471A77	LENS (Busy)
	65P83471A78	EDGE LIGHT
	3P83471A80	SCREW (Top of Front Shell)
	3P83471A81	SCREW (Bottom of Front Shell)
	3P83471A82	SCREW (Rear Shell)
	42P83471A83	TIE (Nylon)
	4P83471A87	WASHER, insulating

NOTE:

Replacement diodes must be ordered by Motorola part number only for optimum performance.



I.M.T.S. CONTROL HEAD CIRCUIT
WITH REVERTIVE CALL
(TCN6090A SERIES)

NOTES:

1. MECHANICAL OPERATION OF CHANNEL SELECTOR SWITCH IS AS FOLLOWS:
   (A) "M", "H" & "R" BUTTON INTERLOCKED TO PERMIT ONLY ONE AT A TIME DEPRESSED.
   (B) WITH "M" BUTTON DEPRESSED, ONLY ONE AT A TIME OF 11 CHANNEL BUTTONS MAY BE DEPRESSED AND LATCHED.
   (C) WITH "R" BUTTON DEPRESSED, ANY SET OF 11 CHANNEL BUTTONS MAY BE DEPRESSED AND LATCHED.
   (D) WITH "H" BUTTON DEPRESSED, ALL CHANNEL BUTTONS ARE RELEASED.
2. * JUMPERS REMOVED FOR ALL CHANNELS NOT IN HOME CHANNEL GROUP.
3. HOOKSWITCH SHOWN IN POSITION CORRESPONDING TO HANDSET ON HOOK.

DIAGRAM NO. 63D81021A87-04

PREVIOUS REVISIONS LISTED
ON BACK OF THIS DIAGRAM

Control Head for 152-162 MC
20 W, ±12 V DC Motorola Car
Telephone Radio Set
Schematic Diagram
Motorola No. 63D81021A87-O4 (T-2663C)
10/20/67-

REVISIONS

DIAG. ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE
01		NON-REF	ADDED ADDITIONAL PARTS
02		S2	WAS 40P83471A03
03		NON-REF	REMOVED 48P83471A86, DIODE
		NON-REF	REMOVED 48P83471A91, CR2 DIODE
04		NON-REF	PART NUMBERS 50D82904E01, E03, E07, E04, E05, E02, AND E06 WERE 50P83928C30, C31, C32, C33, C34, C35 AND C36

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	59P83471A62	TRANSMITTER ASS'Y (Handset)
	59P83471A63	RECEIVER ASS'Y (Handset)
	13P83471A66	ESCUTCHEON (Handset)
	41P83471A68	RESTORING SPRING (Handset)
	40P83471A69	SWITCH ASS'Y (Handset)
	59P83471A70	MEMBRANE ASS'Y (Handset)
	3P83471A71	CAP SCREW, flat head (Handset)
	30P83471A74	CABLE ASS'Y (for 190666)
	33P83471A75	NAMEPLATE ASS'Y (Motorola)
	61P83471A76	LENS (Transmit)
	61P83471A77	LENS (Busy)
	65P83471A78	EDGE LIGHT
	40P83471A79	SWITCH, party (for 190666)
	3P83471A80	SCREW (Top of Front Shell)
	3P83471A81	SCREW (Bottom of Front Shell)
	3P83471A82	SCREW (Rear Shell)
	42P83471A83	TIE (Nylon)
	80P83471A84	BUZZER ASS'Y (for 190666)
	80P83471A85	BUZZER (Only) (for 190666)
	4P83471A87	WASHER, insulating
	3P83471A88	BHM SCREW (Buzzer Mounting)
	9P83471A89	RELAY SOCKET ASS'Y (for 190666)
	43P83471A90	RETAINER, relay (for 190666)

NOTE:

Replacement diodes must be ordered by Motorola part number only for optimum performance.

REVISIONS

DIAG. ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
01		NON-REF	ADDED ADDITIONAL PARTS	PARTS LIST
02		S2	WAS 40P83471A03	PARTS LIST
03		NON-REF	REMOVED 48P83471A86, DIODE	PARTS LIST
		NON-REF	REMOVED 48P83471A91, CR2 DIODE	
04		NON-REF	PART NUMBERS 50D82904E01, E03, E07, E04, E05, E02, AND E06 WERE 50P83928C30, C31, C32, C33, C34, C35 AND C36	PARTS LIST

PARTS LIST for Schematic Diagram 63D81021A87-O4

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		SEMICONDUCTOR DEVICE, diode: SEE NOTE
CR1, 2, 3	48C82392B03	silicon
CR4	48C82178A09	germanium
		LAMP, incandescent:
DS1, 2, 3, 4	65R122665	12-16 volt, 1/10 ampere
		RELAY, armature:
K1	80P8247IA05	12 volt
K2	80A83217B01	12 volt
		RESISTOR, 1/2 watt:
R1	18P83471A08	var; 0-10K; ±20% (min)
R2	6R400060	fixed: 2K; ±5%
		SWITCH:
S1	40P83471A07	key, spst
S2	40P83471A79	pushbutton, dpst
S3	40P83471A10	cradle assembly
		NON-REFERENCED ITEMS
	30P83928C01	CORD, coiled, 6 cond. BLACK
	30P83928C02	CORD, coiled, 6 cond. RED
	30P83928C03	CORD, coiled, 6 cond. ROSE PINK
	30P83928C04	CORD, coiled, 6 cond. AQUA BLUE
	30P83928C05	CORD, coiled, 6 cond. LIGHT BEIGE
	30P83928C06	CORD, coiled, 6 cond. WHITE
	30P83928C07	CORD, coiled, 6 cond. TURQUOISE
	15P83928C08	CAP, handset (Xmtr.) BLACK
	15P83928C09	CAP, handset (Xmtr.) RED
	15P83928C10	CAP, handset (Xmtr.) ROSE PINK
	15P83928C11	CAP, handset (Xmtr.) AQUA BLUE
	15P83928C12	CAP, handset (Xmtr.) LIGHT BEIGE
	15P83928C13	CAP, handset (Xmtr.) WHITE
	15P83928C14	CAP, handset (Xmtr.) TURQUOISE
	15P83928C15	CAP, handset (Rcvr.) BLACK
	15P83928C16	CAP, handset (Rcvr.) RED
	15P83928C17	CAP, handset (Rcvr.) ROSE PINK
	15P83928C18	CAP, handset (Rcvr.) AQUA BLUE
	15P83928C19	CAP, handset (Rcvr.) LIGHT BEIGE
	15P83928C20	CAP, handset (Rcvr.) WHITE
	15P83928C21	CAP, handset (Rcvr.) TURQUOISE
	47P83928C22	PLUNGER BAR, handset (Motorola) BLACK
	47P83928C23	PLUNGER BAR, handset RED
	47P83928C24	PLUNGER BAR, handset ROSE PINK
	47P83928C25	PLUNGER BAR, handset AQUA BLUE
	47P83928C26	PLUNGER BAR, handset LIGHT BEIGE
	47P83928C27	PLUNGER BAR, handset WHITE
	47P83928C28	PLUNGER BAR, handset TURQUOISE
	55P83928C29	KEY (only) (for 40P83471A07)
	50D82904E01	HANDSET ASS'Y, incl. CORD, coil BLACK (Western Electric)
	50D82904E03	HANDSET ASS'Y, incl. CORD, coil RED (Western Electric)
	50D82904E07	HANDSET ASS'Y incl. CORD, coil ROSE PINK (Western Electric)
	50D82904E04	HANDSET ASS'Y incl. CORD, coil AQUA BLUE (Western Electric)
	50D82904E05	HANDSET ASS'Y, incl. CORD, coil LIGHT BEIGE (Western Electric)
	50D82904E02	HANDSET ASS'Y, incl. CORD, coil WHITE (Western Electric)
	50D82904E06	HANDSET ASS'Y, incl. CORD coil TURQUOISE (Western Electric)
	50D83449A01	HANDSET ASS'Y; incl. CORD, coiled: BLACK (Motorola)
	50D83449A02	HANDSET ASS'Y; incl. CORD, coiled: WHITE (Motorola)
	50D83449A03	HANDSET ASS'Y; incl. CORD, coiled: RED (Motorola)
	50D83449A04	HANDSET ASS'Y; incl. CORD, coiled: BLUE (Motorola)
	50D83449A05	HANDSET ASS'Y; incl. CORD, coiled: BEIGE (Motorola)
	50D83449A06	HANDSET ASS'Y; incl. CORD, coiled: TURQUOISE (Motorola)
	50D83449A07	HANDSET ASS'Y; incl. CORD, coiled: PINK (Motorola)
	55P83928C37	HANDLE, BLACK
	55P83928C38	HANDLE, RED
	55P83928C39	HANDLE, ROSE PINK
	55P83928C40	HANDLE, AQUA BLUE
	55P83928C41	HANDLE, LIGHT BEIGE
	55P83928C42	HANDLE, WHITE
	55P83928C43	HANDLE, TURQUOISE
	7P83471A01	BRACKET, mounting
	42P83471A02	RING, lockout
	40P83471A04	SWITCH, channel selector
	80P83471A05	RELAY, ring
	40P83471A07	SWITCH, lock (W/2 KEYS)
	18P83471A08	POTENTIOMETER
	40P83471A10	CRADLE SWITCH ASS'Y
	54P83471A12	STRIP, number card
	33P83471A13	NAMEPLATE ASS'Y, "Radio Telephone"
	80P83471A14	RELAY, for Revertive Call
	80P83471A15	BUZZER
	38P83471A16	PUSHBUTTON ASS'Y (JL)
	38P83471A17	PUSHBUTTON ASS'Y (YL)
	38P83471A18	PUSHBUTTON ASS'Y (JP)
	38P83471A19	PUSHBUTTON ASS'Y (YP)
	38P83471A20	PUSHBUTTON ASS'Y (YJ)
	38P83471A21	PUSHBUTTON ASS'Y (YK)
	38P83471A22	PUSHBUTTON ASS'Y (JS)
	38P83471A23	PUSHBUTTON ASS'Y (YS)
	38P83471A24	PUSHBUTTON ASS'Y (YR)
	38P83471A25	PUSHBUTTON ASS'Y (JK)
	38P83471A26	PUSHBUTTON ASS'Y (JR)
	38P83471A27	PUSHBUTTON ASS'Y (H)
	38P83471A28	PUSHBUTTON ASS'Y (M)
	38P83471A29	PUSHBUTTON ASS'Y (R)
	38P83471A31	PUSHBUTTON ASS'Y (no Designation)
	38P83471A32	PUSHBUTTON ASS'Y (P)
	42P83471A33	CLAMP (LH)
	42P83471A34	CLAMP (RH)
	41P83471A35	SPRINGS, clamp
	47P83471A36	PIVOT PIN, clamp
	45P83471A37	ACTUATOR ARM ASS'Y
	41P83471A38	SPRING, actuator arm
	41P83471A39	SPRING, large (for Cradle Switch)
	7P83471A40	CRADLE SWITCH BRACKET ASS'Y
	9P83471A41	RELAY SOCKET ASS'Y (Ring)
	43P83471A42	RETAINER, relay ring
	43P83471A43	SPACER, mounting (threaded hex)
	43P83471A44	TERMINAL BOARD ASS'Y (14 cont. - diode & resistor)
	31P83471A45	TERMINAL BOARD ASS'Y (4 cont.)
	43P83471A46	SPACER, term. board
	7P83471A47	BRACKET, term. board mounting (LH)
	7P83471A48	BRACKET, term. board mounting (RH)
	5P83471A49	GROMMET
	5P83471A50	GROMMET (for RH Mounting Bracket)
	2P83471A51	SPEED NUT, "U" type
	32P83471A52	GASKET, dial
	46P83471A53	FINGER STOP, dial
	26P83471A54	SHIELD, light
	7P83471A55	BRACKET, dial light mounting
	7P83471A56	BRACKET, lamp mounting (Trans - Busy)
	9P83471A57	LAMP SOCKET ASS'Y (on-off)
	65P83471A58	LAMP (Miniature Bay. Base)
	7P83471A59	MOUNTING BRACKET ASS'Y (Base Plate) RH
	7P83471A60	MOUNTING BRACKET ASS'Y (Base Plate) LH
	59P83471A62	TRANSMITTER ASS'Y (Handset)
	59P83471A63	RECEIVER ASS'Y (Handset)
	13P83471A66	ESCUTCHEON (Handset)
	41P83471A68	RESTORING SPRING (Handset)
	40P83471A69	SWITCH ASS'Y (Handset)
	59P83471A70	MEMBRANE ASS'Y (Handset)
	3P83471A71	CAP SCREW, flat head (Handset)
	30P83471A74	CABLE ASS'Y (for 190666)
	33P83471A75	NAMEPLATE ASS'Y (Motorola)
	61P83471A76	LENS (Transmit)
	61P83471A77	LENS (Busy)
	65P83471A78	EDGE LIGHT
	40P83471A79	SWITCH, party (for 190666)
	3P83471A80	SCREW (Top of Front Shell)
	3P83471A81	SCREW (Bottom of Front Shell)
	3P83471A82	SCREW (Rear Shell)
	42P83471A83	TIE (Nylon)
	80P83471A84	BUZZER ASS'Y (for 190666)
	80P83471A85	BUZZER (Only) (for 190666)
	4P83471A87	WASHER, insulating
	3P83471A88	BHM SCREW (Buzzer Mounting)
	9P83471A89	RELAY SOCKET ASS'Y (for 190666)
	43P83471A90	RETAINER, relay (for 190666)

NOTE:

Replacement diodes must be ordered by Motorola part number only for optimum performance.

REVISIONS

DIAG. ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
01		NON-REF	ADDED ADDITIONAL PARTS	PARTS LIST
02		S2	WAS 40P83471A03	PARTS LIST
03		NON-REF	REMOVED 48P83471A86, DIODE	PARTS LIST
		NON-REF	REMOVED 48P83471A91, CR2 DIODE	
04		NON-REF	PART NUMBERS 50D82904E01, E03, E07, E04, E05, E02, AND E06 WERE 50P83928C30, C31, C32, C33, C34, C35 AND C36	PARTS LIST

PARTS LIST for Schematic Diagram 63D81021A87-O4

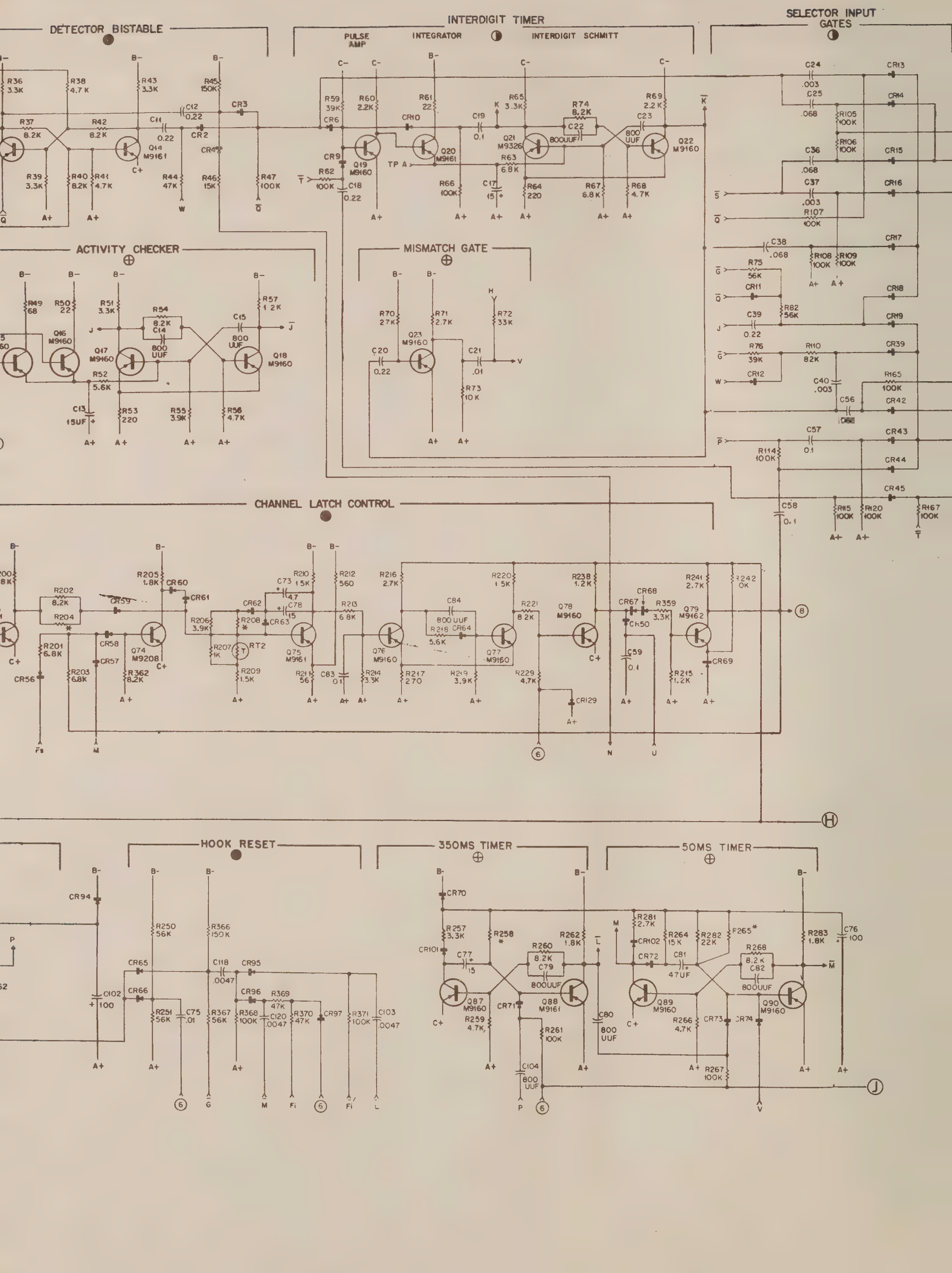
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		SEMICONDUCTOR DEVICE, diode: SEE NOTE
CR1, 2, 3	48C82392B03	silicon
CR4	48C82178A09	germanium
		LAMP, incandescent:
DS1, 2, 3, 4	65R122665	12-16 volt, 1/10 ampere
		RELAY, armature:
K1	80P82471A05	12 volt
K2	80A83217B01	12 volt
		RESISTOR, 1/2 watt:
R1	18P83471A08	var; 0-10K; ±20% (min)
R2	6R400060	fixed: 2K; ±5%
		SWITCH:
S1	40P83471A07	key, spst
S2	40P83471A79	pushbutton, dpst
S3	40P83471A10	cradle assembly
		NON-REFERENCED ITEMS
	30P83928C01	CORD, coiled, 6 cond. BLACK
	30P83928C02	CORD, coiled, 6 cond. RED
	30P83928C03	CORD, coiled, 6 cond. ROSE PINK
	30P83928C04	CORD, coiled, 6 cond. AQUA BLUE
	30P83928C05	CORD, coiled, 6 cond. LIGHT BEIGE
	30P83928C06	CORD, coiled, 6 cond. WHITE
	30P83928C07	CORD, coiled, 6 cond. TURQUOISE
	15P83928C08	CAP, handset (Xmtr.) BLACK
	15P83928C09	CAP, handset (Xmtr.) RED
	15P83928C10	CAP, handset (Xmtr.) ROSE PINK
	15P83928C11	CAP, handset (Xmtr.) AQUA BLUE
	15P83928C12	CAP, handset (Xmtr.) LIGHT BEIGE
	15P83928C13	CAP, handset (Xmtr.) WHITE
	15P83928C14	CAP, handset (Xmtr.) TURQUOISE
	15P83928C15	CAP, handset (Rcvr.) BLACK
	15P83928C16	CAP, handset (Rcvr.) RED
	15P83928C17	CAP, handset (Rcvr.) ROSE PINK
	15P83928C18	CAP, handset (Rcvr.) AQUA BLUE
	15P83928C19	CAP, handset (Rcvr.) LIGHT BEIGE
	15P83928C20	CAP, handset (Rcvr.) WHITE
	15P83928C21	CAP, handset (Rcvr.) TURQUOISE
	47P83928C22	PLUNGER BAR, handset (Motorola) BLACK
	47P83928C23	PLUNGER BAR, handset RED
	47P83928C24	PLUNGER BAR, handset ROSE PINK
	47P83928C25	PLUNGER BAR, handset AQUA BLUE
	47P83928C26	PLUNGER BAR, handset LIGHT BEIGE
	47P83928C27	PLUNGER BAR, handset WHITE
	47P83928C28	PLUNGER BAR, handset TURQUOISE
	55P83928C29	KEY (only) (for 40P83471A07)
	50D82904E01	HANDSET ASS'Y, incl. CORD, coil BLACK (Western Electric)
	50D82904E03	HANDSET ASS'Y, incl. CORD, coil RED (Western Electric)
	50D82904E07	HANDSET ASS'Y incl. CORD, coil ROSE PINK (Western Electric)
	50D82904E04	HANDSET ASS'Y incl. CORD, coil AQUA BLUE (Western Electric)
	50D82904E05	HANDSET ASS'Y, incl. CORD, coil LIGHT BEIGE (Western Electric)
	50D82904E02	HANDSET ASS'Y, incl. CORD, coil WHITE (Western Electric)
	50D82904E06	HANDSET ASS'Y, incl. CORD coil TURQUOISE (Western Electric)

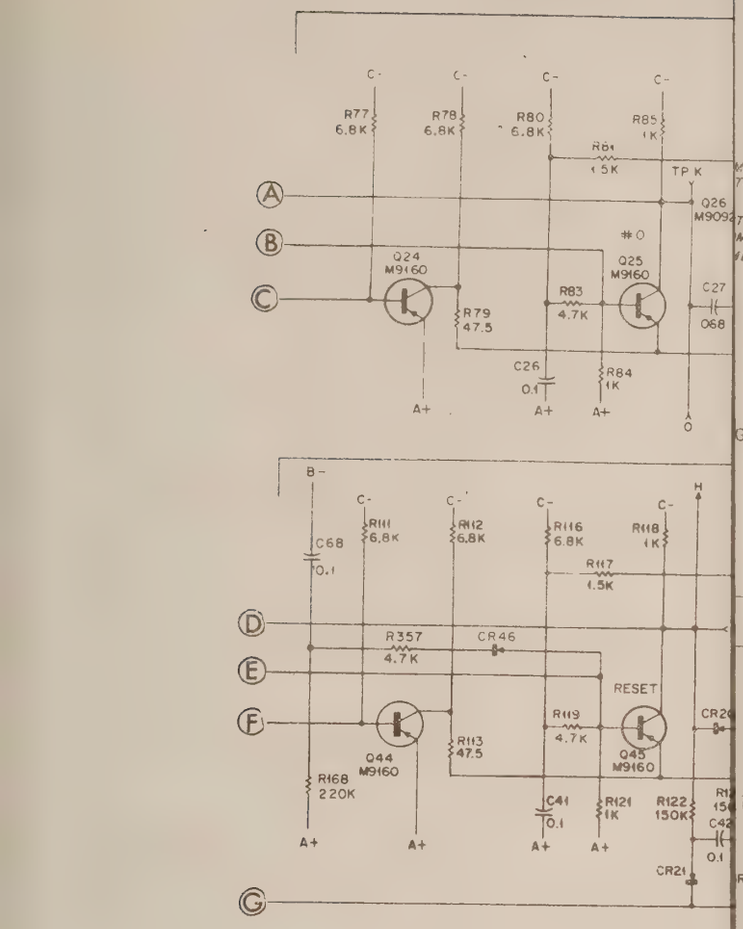
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	50D83449A01	HANDSET ASS'Y; incl. CORD, coiled: BLACK (Motorola)
	50D83449A02	HANDSET ASS'Y; incl. CORD, coiled: WHITE (Motorola)
	50D83449A03	HANDSET ASS'Y; incl. CORD, coiled: RED (Motorola)
	50D83449A04	HANDSET ASS'Y; incl. CORD, coiled: BLUE (Motorola)
	50D83449A05	HANDSET ASS'Y; incl. CORD, coiled: BEIGE (Motorola)
	50D83449A06	HANDSET ASS'Y; incl. CORD, coiled: TURQUOISE (Motorola)
	50D83449A07	HANDSET ASS'Y; incl. CORD, coiled: PINK (Motorola)
	55P83928C37	HANDLE, BLACK
	55P83928C38	HANDLE, RED
	55P83928C39	HANDLE, ROSE PINK
	55P83928C40	HANDLE, AQUA BLUE
	55P83928C41	HANDLE, LIGHT BEIGE
	55P83928C42	HANDLE, WHITE
	55P83928C43	HANDLE, TURQUOISE
	7P83471A01	BRACKET, mounting
	42P83471A02	RING, lockout
	40P83471A04	SWITCH, channel selector
	80P83471A05	RELAY, ring
	40P83471A07	SWITCH, lock (W/2 KEYS)
	18P83471A08	POTENTIOMETER
	40P83471A10	CRADLE SWITCH ASS'Y
	54P83471A12	STRIP, number card
	33P83471A13	NAMEPLATE ASS'Y, "Radio Telephone"
	80P83471A14	RELAY, for Revertive Call
	80P83471A15	BUZZER
	38P83471A16	PUSHBUTTON ASS'Y (JL)
	38P83471A17	PUSHBUTTON ASS'Y (YL)
	38P83471A18	PUSHBUTTON ASS'Y (JP)
	38P83471A19	PUSHBUTTON ASS'Y (YP)
	38P83471A20	PUSHBUTTON ASS'Y (YJ)
	38P83471A21	PUSHBUTTON ASS'Y (YK)
	38P83471A22	PUSHBUTTON ASS'Y (JS)
	38P83471A23	PUSHBUTTON ASS'Y (YS)
	38P83471A24	PUSHBUTTON ASS'Y (YR)
	38P83471A25	PUSHBUTTON ASS'Y (JK)
	38P83471A26	PUSHBUTTON ASS'Y (JR)
	38P83471A27	PUSHBUTTON ASS'Y (H)
	38P83471A28	PUSHBUTTON ASS'Y (M)
	38P83471A29	PUSHBUTTON ASS'Y (R)
	38P83471A31	PUSHBUTTON ASS'Y (no Designation)
	38P83471A32	PUSHBUTTON ASS'Y (P)
	42P83471A33	CLAMP (LH)
	42P83471A34	CLAMP (RH)
	41P83471A35	SPRINGS, clamp
	47P83471A36	PIVOT PIN, clamp
	45P83471A37	ACTUATOR ARM ASS'Y
	41P83471A38	SPRING, actuator arm
	41P83471A39	SPRING, large (for Cradle Switch)
	7P83471A40	CRADLE SWITCH BRACKET ASS'Y
	9P83471A41	RELAY SOCKET ASS'Y (Ring)
	43P83471A42	RETAINER, relay ring
	43P83471A43	SPACER, mounting (threaded hex)
	43P83471A44	TERMINAL BOARD ASS'Y (14 cont. - diode & resistor)
	31P83471A45	TERMINAL BOARD ASS'Y (4 cont.)
	43P83471A46	SPACER, term. board
	7P83471A47	BRACKET, term. board mounting (LH)
	7P83471A48	BRACKET, term. board mounting (RH)
	5P83471A49	GROMMET
	5P83471A50	GROMMET (for RH Mounting Bracket)
	2P83471A51	SPEED NUT, "U" type
	32P83471A52	GASKET, dial
	46P83471A53	FINGER STOP, dial
	26P83471A54	SHIELD, light
	7P83471A55	BRACKET, dial light mounting
	7P83471A56	BRACKET, lamp mounting (Trans - Busy)
	9P83471A57	LAMP SOCKET ASS'Y (on-off)
	65P83471A58	LAMP (Miniature Bay. Base)
	7P83471A59	MOUNTING BRACKET ASS'Y (Base Plate) RH
	7P83471A60	MOUNTING BRACKET ASS'Y (Base Plate) LH

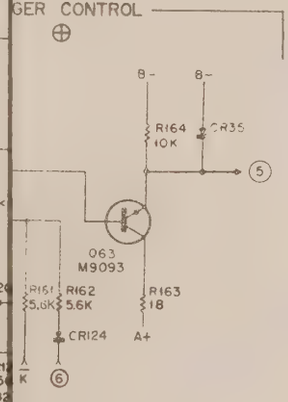
REFERENCE SYMBOL	MOTOROLA PART NO	DESCRIPTION
	59P83471A62	TRANSMITTER ASS'Y (Handset)
	59P83471A63	RECEIVER ASS'Y (Handset)
	13P83471A66	ESCUTCHEON (Handset)
	41P83471A68	RESTORING SPRING (Handset)
	40P83471A69	SWITCH ASS'Y (Handset)
	59P83471A70	MEMBRANE ASS'Y (Handset)
	3P83471A71	CAP SCREW, flat head (Handset)
	30P83471A74	CABLE ASS'Y (for 190666)
	33P83471A75	NAMEPLATE ASS'Y (Motorola)
	61P83471A76	LENS (Transmit)
	61P83471A77	LENS (Busy)
	65P83471A78	EDGE LIGHT
	40P83471A79	SWITCH, party (for 190666)
	3P83471A80	SCREW (Top of Front Shell)
	3P83471A81	SCREW (Bottom of Front Shell)
	3P83471A82	SCREW (Rear Shell)
	42P83471A83	TIE (Nylon)
	80P83471A84	BUZZER ASS'Y (for 190666)
	80P83471A85	BUZZER (Only) (for 190666)
	4P83471A87	WASHER, insulating
	3P83471A88	BHM SCREW (Buzzer Mounting)
	9P83471A89	RELAY SOCKET ASS'Y (for 190666)
	43P83471A90	RETAINER, relay (for 190666)

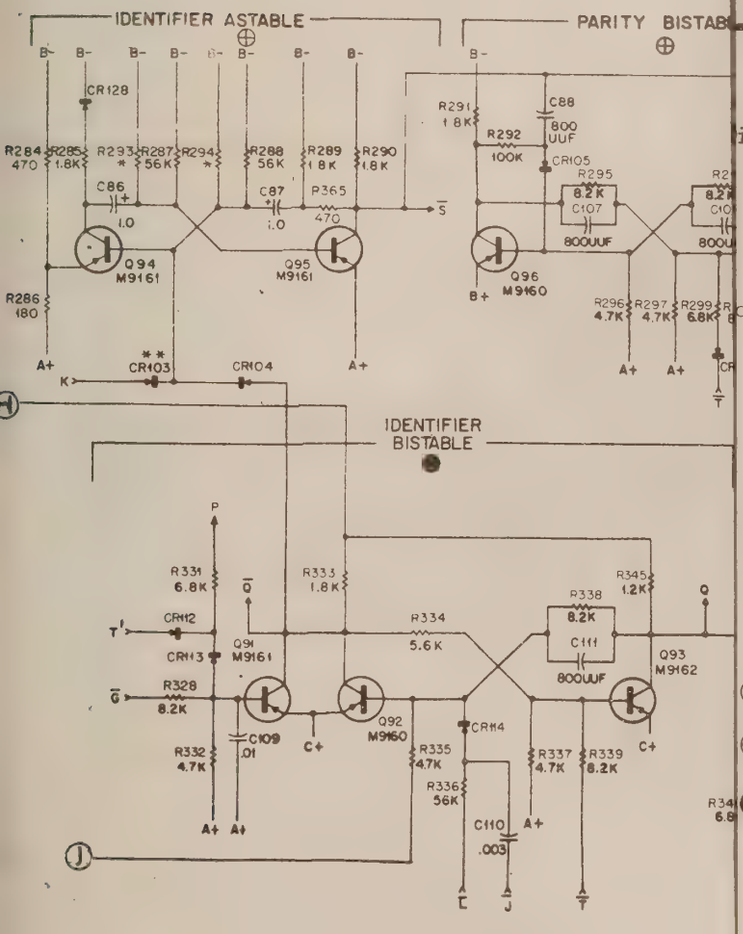
NOTE:

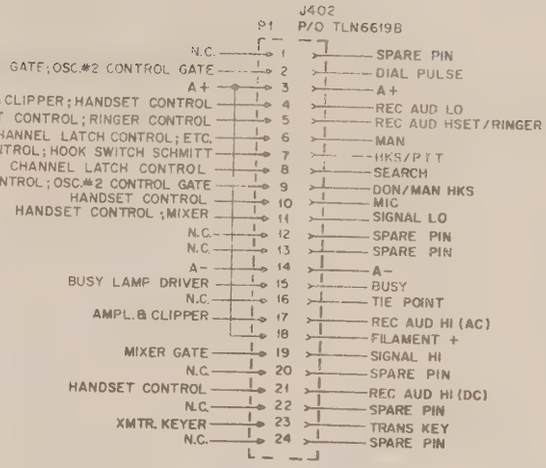
Replacement diodes must be ordered by Motorola part number only for optimum performance.


DETECTOR BISTABLE
INTERDIGIT TIMER
PULSE AMP
INTEGRATOR
INTERDIGIT SCHMITT
SELECTOR INPUT GATES
ACTIVITY CHECKER
MISMATCH GATE
CHANNEL LATCH CONTROL
HOOK RESET
350MS TIMER
50MS TIMER









RAM NO. 63E81021A27-L

ion manual revision MR-2149A

For 68P81044A05-A

iagram 63E81021A27 with this Diagram 63E81021A27-L.

Also used in 68P81022A65
68P81028A60

OTES:

UNLESS OTHERWISE STATED CAPACITOR VALUES ARE IN MICROFARADS.
UNLESS OTHERWISE STATED RESISTOR VALUES ARE IN OHMS, K=1000.
LEADS ENDING IN LETTER DESIGNATIONS A THROUGH E REFER TO DESTINATIONS IN THE FILTER AND BIAS SUPPLY.
LEADS ENDING IN LETTER DESIGNATIONS F THROUGH W REFER TO DESTINATIONS IN OTHER CIRCUITS. LETTERS WITH BARS OVER THEM INDICATE NEGATIVE GOING OUTPUTS. REFER TO THE "CIRCUIT ROUTING CHART" IN THE INSTRUCTION MANUAL.
LETTER DESIGNATIONS TP A THROUGH TP Z INDICATE TEST POINTS ON THE PRINTED CIRCUIT BOARD. REFER TO EPD-10272.
JUMPERS SHOULD BE CONNECTED TO THE APPROPRIATE DIGIT CORRESPONDING TO THE CODE NUMBER. REFER TO CIRCUIT BOARD DETAIL EPD-10272.
CIRCLED NUMBERS INDICATE ELECTRICAL CONNECTIONS TO PLUG P1.
* ASTERISK DENOTES FACTORY SELECTED COMPONENT
** DOUBLE ASTERISK DENOTES COMPONENTS LOCATED ON MODEL TLN6814A SELECTOR BOARD.

◑ DENOTES CIRCUITRY LOCATED ON MODEL TLN6814A SELECTOR CIRCUIT BOARD.

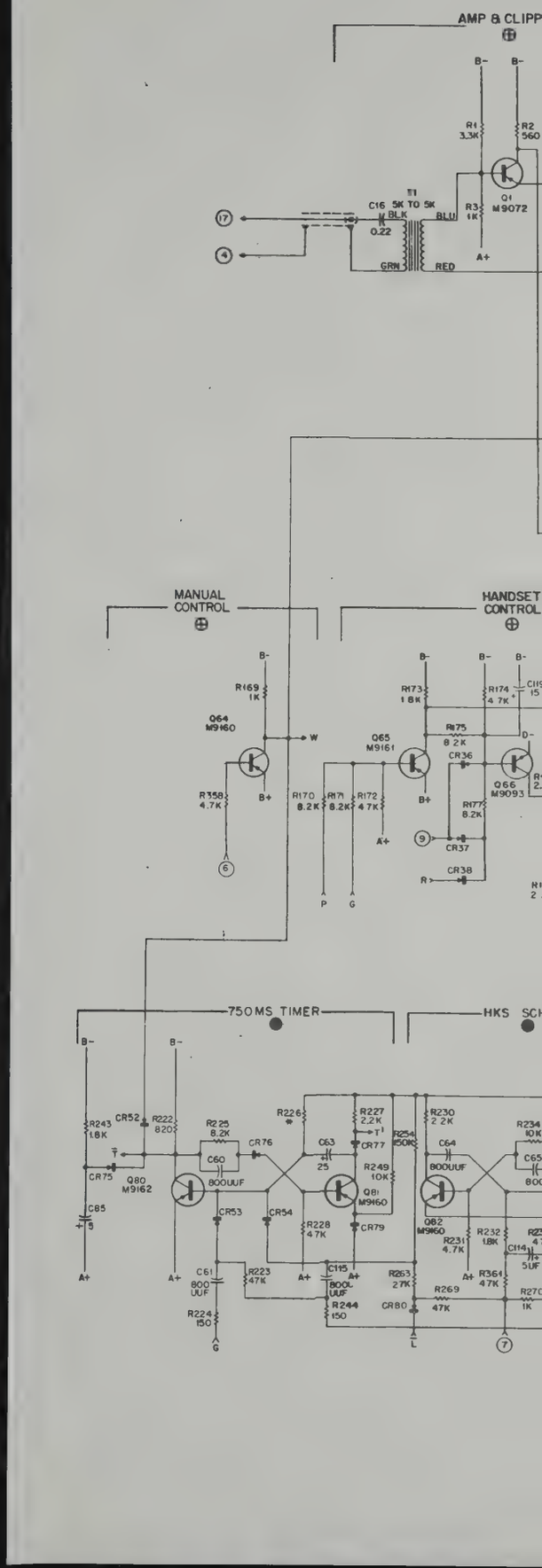
⊕ DENOTES CIRCUITRY LOCATED ON MODEL TLN6815A OSCILLATOR & DETECTOR CIRCUIT BOARD.

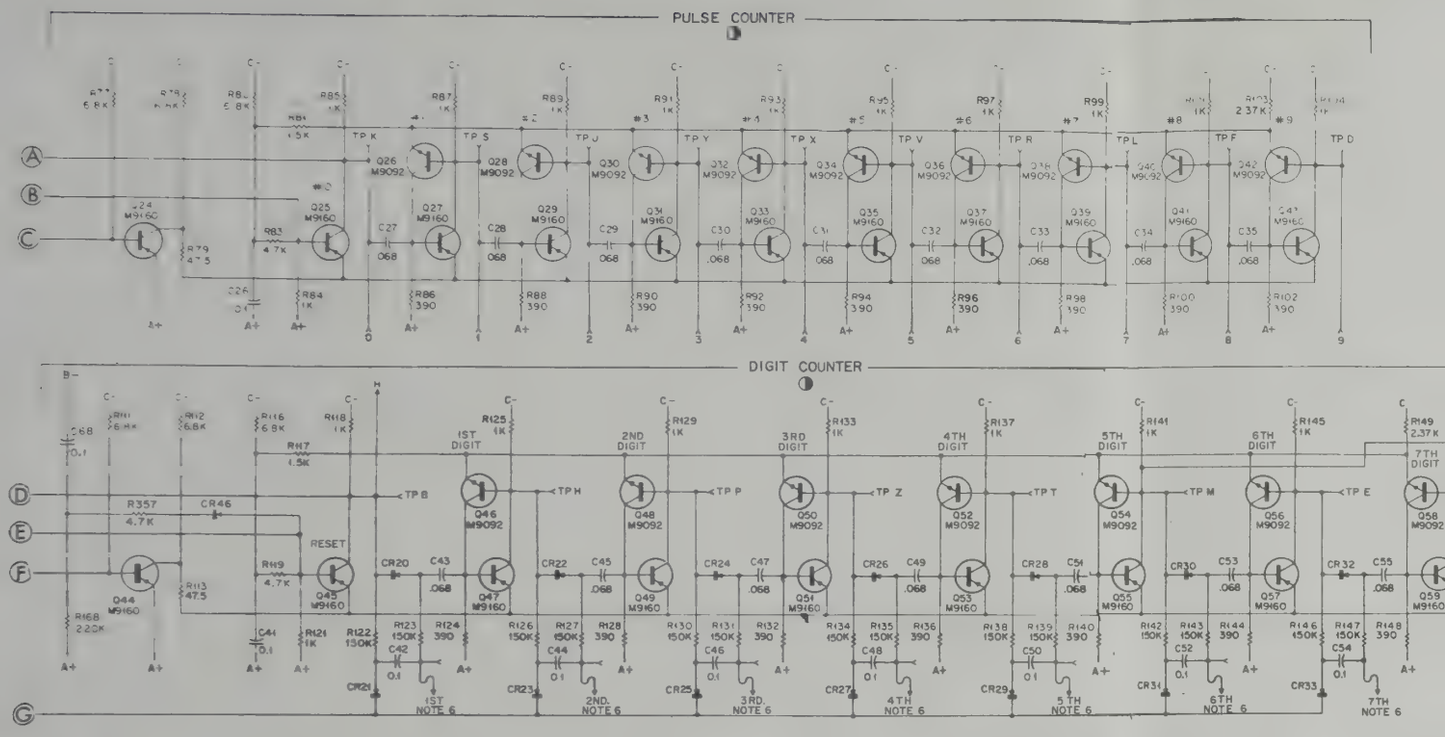
● DENOTES CIRCUITRY LOCATED ON MODEL TLN6816A CONTROL CIRCUIT BOARD.

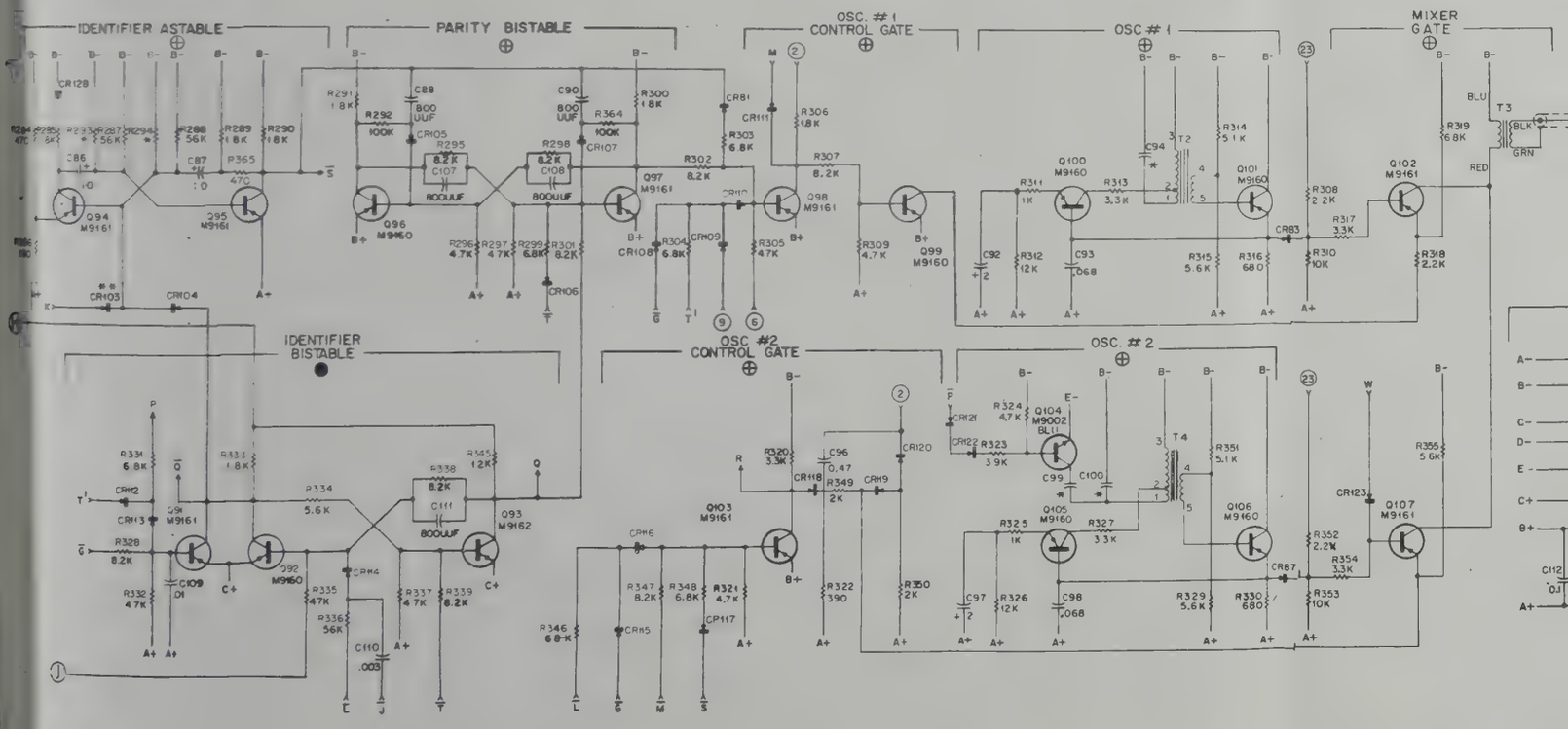
PREVIOUS REVISIONS LISTED
ON BACK OF THIS DIAGRAM

EPD-10458-O

Supervisory Unit for 152-162 MC,
20 W, ±12 V DC Motorola Car Telephone
Radio Set Schematic Diagram
Motorola No. 63E81021A27-L
4/10/67-

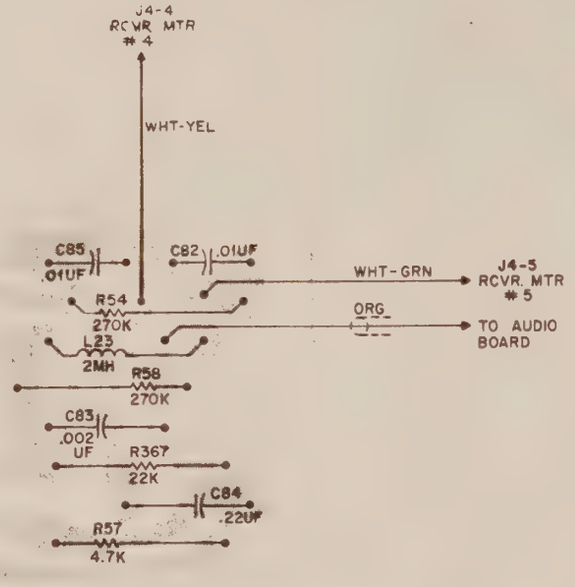

AMP & CLIPP
B-
R1 3.3K
R2 560
Q1 M9072
T1
C16 5K TO 5K
BLK
BLU
0.22
R3 1K
A+
GRN
RED
MANUAL CONTROL
HANDSET CONTROL
R169 1K
Q64 M9160
R358 4.7K
B+
R170 8.2K
R171 8.2K
R172 4.7K
R173 1.8K
R174 4.7K
R175 8.2K
Q65 M9161
CR36
Q66 M9093
R177 8.2K
CR37
CR38
P
G
750MS TIMER
HKS SCH
R243 1.8K
CR52
R222 820
R225 8.2K
CR76
C60 800UUF
CR75
Q80 M9162
C85
CR53
CR54
R223 47K
C61 800 UUF
R224 150
R226
R227 2.2K
CR77
C63 25
R249 10K
Q81 M9160
R228 47K
CR79
C115 800L UUF
R244 150
R254 150K
R230 2.2K
C64 800UUF
Q82 M9160
R231 4.7K
R232 1.8K
R263 27K
R269 47K
CR80
R364 47K
R270 1K
C114 5UF
R234 10K
C65 800
L

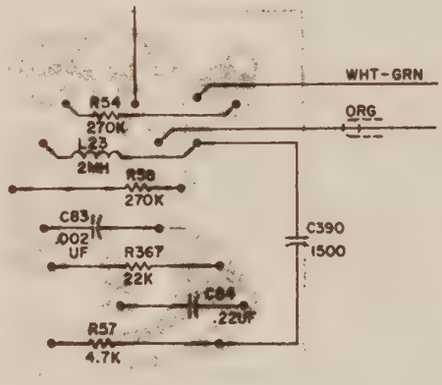

PULSE COUNTER
DIGIT COUNTER
1ST DIGIT
2ND DIGIT
3RD DIGIT
4TH DIGIT
5TH DIGIT
6TH DIGIT
7TH DIGIT
RESET


IDENTIFIER ASTABLE
PARITY BISTABLE
OSC. #1 CONTROL GATE
OSC. #1
MIXER GATE
IDENTIFIER BISTABLE
OSC #2 CONTROL GATE
OSC. #2

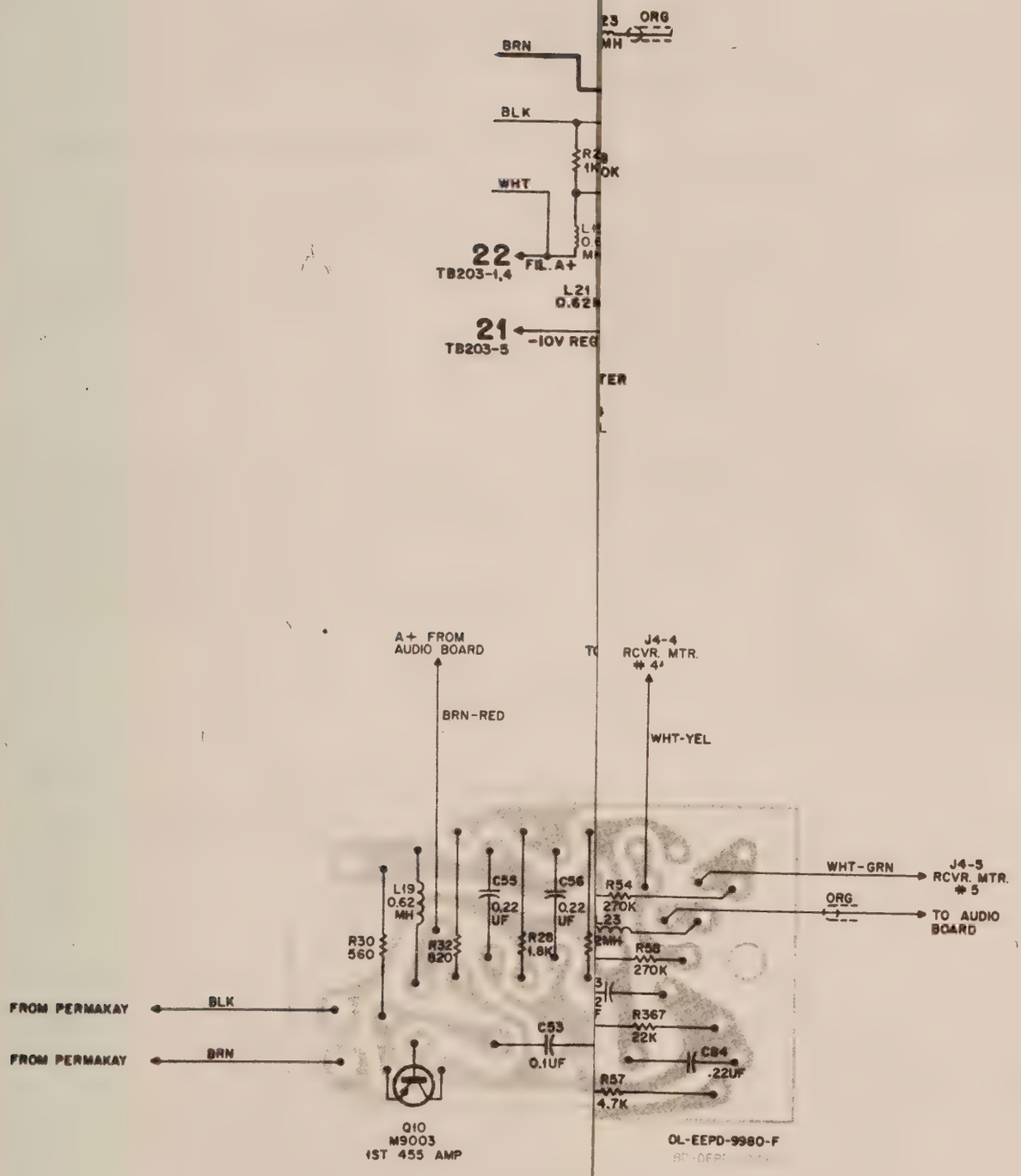
REVISIONS

DIAG. ISSUE	BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
A	TLN6623B-1	C82, 85	REMOVED 21D82428B12 .01 uf CIRCUIT WAS AS SHOWN BELOW	UPPER RIGHT CORNER OF BOARD
B	TLN6623-B		ADDED 68P81022A65	DIAGRAM BOOKLET LIST
C	TLN6623B	C64	WAS 8D82905G11, 0.22 uuf	LEFT OF Q12
		C380	WAS 8D82905G07, 0.1 uf	ABOVE Q12
D	TLN6623B	Q313	WAS 48R869196 TYPE M9196	A.G.C.
E	TLN6623B-2	C390	ADDED 1500 uuf	DISCRIMINATOR
F	TLN6623B-3	C390	REMOVED 21D82187B11 1500 uuf CIRCUIT WAS AS SHOWN BELOW	LOWER RIGHT OF CKT. BD.
G	TLN6623B-4	C57,60, 62,69	WERE 21D82428B12, .01 uf +70-30%; 100 V	PARTS LIST





REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uuf; unl. stated
C51, 53, 64, 68, 72, 381	8D82905G07	0.1 uf ±10%; 25 v
C55, 56, 84, 374, 375, 380, 382	8D82905G11	.22 ±10%; 25 v
C57, 60, 62, 69	21D82428B58	.01 uf +80-20%; 500 v
C58, 63	21C82187B17	820 ±10%; 500 v
C59, 71	21D82133G06	27 ±5%; 500 v; NP0
C70, 373, 378	21C82187B18	1500 ±10%; 100 v
C78	21K848159	750 ±10%; 300 v
C80	21D82133G28	80 ±10%; N1500
C83	21D82428B25	.002 uf ±20%; 20 v
C376	21C82372C04	.05 uf +80-20%; 25 v
C383, 384	21K859773	2500 ±5%; 500 v
		SEMICONDUCTOR DEVICE, diode: SEE NOTE 1
CR2, 3	48C82921G01	germanium
CR4, 5	48C82139G01	germanium
CR10, 11	48C82392B03	silicon
		COIL, RF: choke;
L19, 21	24D82135G01	0.62 mh
L23	24D82135G07	2.0 mh
		TRANSISTOR: SEE NOTE 1
Q10, 12	48R869003	P-N-P; type M9003
Q11, 13	48R869185	N-P-N; type M9185
Q313	48R869197	N-P-N; type M9197
		RESISTOR, fixed: ±10%; 1/2 w; unl. stated
R28	6R2089	1.8K
R29, 37	6R6229	1K
R30, 51, 366	6R6291	560
R32	6R6269	820
R33	6R2004	8.2K
R34	6R6038	1.5K
R35, 43, 363	6R5591	18K
R36, 38	6R6373	150
R39	6R5577	2.7K
R40, 57	6R6080	4.7K
R41, 391	6R6040	680
R44	6R6320	10K
R45	6R5659	3.9K
R46, 365	6R6270	220
R54, 58	6R6414	270K
R55, 56	6K129886	27K ±5%, 1/4 w
R362	6R6444	180K
R364	6R6326	100
R367	6R6397	22K
		TRANSFORMER,
T3	24V80902A86	incl. 76K855159 CORE, tuning; 2 req'd
NON-REFERENCED ITEMS		
	1V80737A31	CIRCUIT BOARD ASSY. (eyeleted)
	26A82451G03	SHIELD, coil



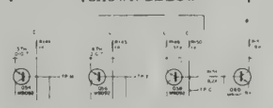
PREVIOUS REVISIONS SHOWN
ON BACK OF THIS DIAGRAM

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455 KC IF Circuit Board Detail
Model TLN6623B-4 used in
152-162 MC, 20 W, ±12 V DC
Motorola Car Telephone Receiver
Motorola No. EPD-9981-G (MR-2115B)
2/8/67-

REVISIONS

DIAG. ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION	REFER TO CIRCUIT BOARD
O1	TLN6815A				OSC. DET. BD. EPD-10276-O
	TLN6619B	J402	CHANGED OUTPUT DESIGNATIONS	EXTREME RIGHT OF SCHEMATIC DIAGRAM	NONE
O2	TLN6814A				SELECTOR BD. EPD-10272-B
	TLN6815A				OSC. DET. BD. EPD-10276-B
	TLN6816A				CONTROL BD. EPD-10268-B
A	TLN6814A-1				SELECTOR BD. EPD-10272-C
	TLN6815A-1				OSC. DET. BD. EPD-10276-C
	TLN6816A-1				CONTROL BD. EPD-10268-C
B	TLN6814A-2				SELECTOR BD. EPD-10272-D
	TKN6171A-1		CIRCUIT WAS AS SHOWN BELOW		NONE
C	TLN6816A-2				CONTROL BD. EPD-10268-D
D	TLN6815A-2				EPD-10276-E
E	TLN6816A-3				CONTROL BD. EPD-10268-F
	TLN6815A-3				OSC. DET. BD. EPD-10276-G
F	TLN6815A-4				OSC. DET. BD. EPD-10276-H
G	TLN6816A-4				CONTROL BD. EPD-13150-O
H	TLN6815A-5				OSC. DET. BD. EPD-10276-K
J	TLN6816A-5				CONTROL BD. EPD-13150-A
K	TLN6814A-3				SELECTOR BD. EPD-10272-F
L	TLN6815A-6				OSC. DET. BD. EPD-10276-L



PARTS LISTS FOR PRINTED CIRCUIT BOARDS ARE ON THE BACK OF THE CORRESPONDING PRINTED CIRCUIT BOARD DETAILS

TKN6171A Intercabling Kit

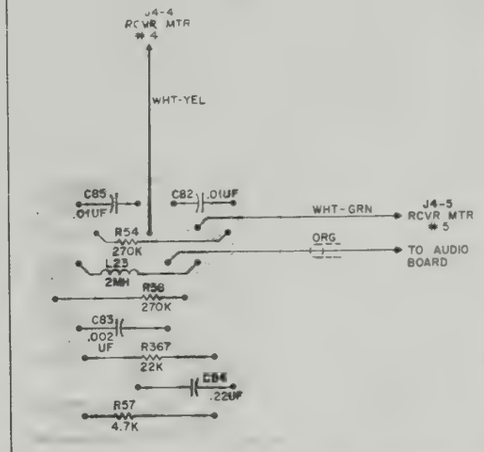
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
P1	28B851574	CONNECTOR, plug: male; 24 contact
NON-REFERENCED ITEMS		
	55B83032A01	HANDLE, connector
	42K861179	CLAMP, cable: 5/16" dia.
	37C82378B01	TUBING, rubber; 12 req'd

TLN6813A Supervisory Unit Chassis Kit

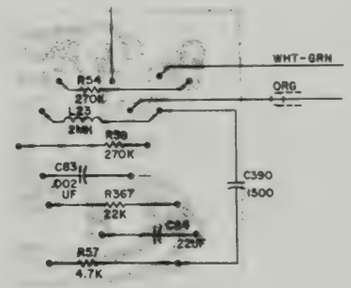
	75B83027A01	PAD, crystal
	75A83677B01	PAD, connector
	14B83021A01	INSULATOR
	42K802007	CLAMP, cable
	3A82227A04	SCREW, special (4-40 x 1/4) 19 req'd.
	55C83024A01	HINGE, bracket
	41A83152A01	SPRING, retaining
	3A83025A01	SCREW, pivot

REVISIONS

DIAG. ISSUE	BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
A	TLN6623B-1	C82, 85	REMOVED 21D82428B12 .01 uf	UPPER RIGHT CORNER OF BOARD
			CIRCUIT WAS AS SHOWN BELOW	



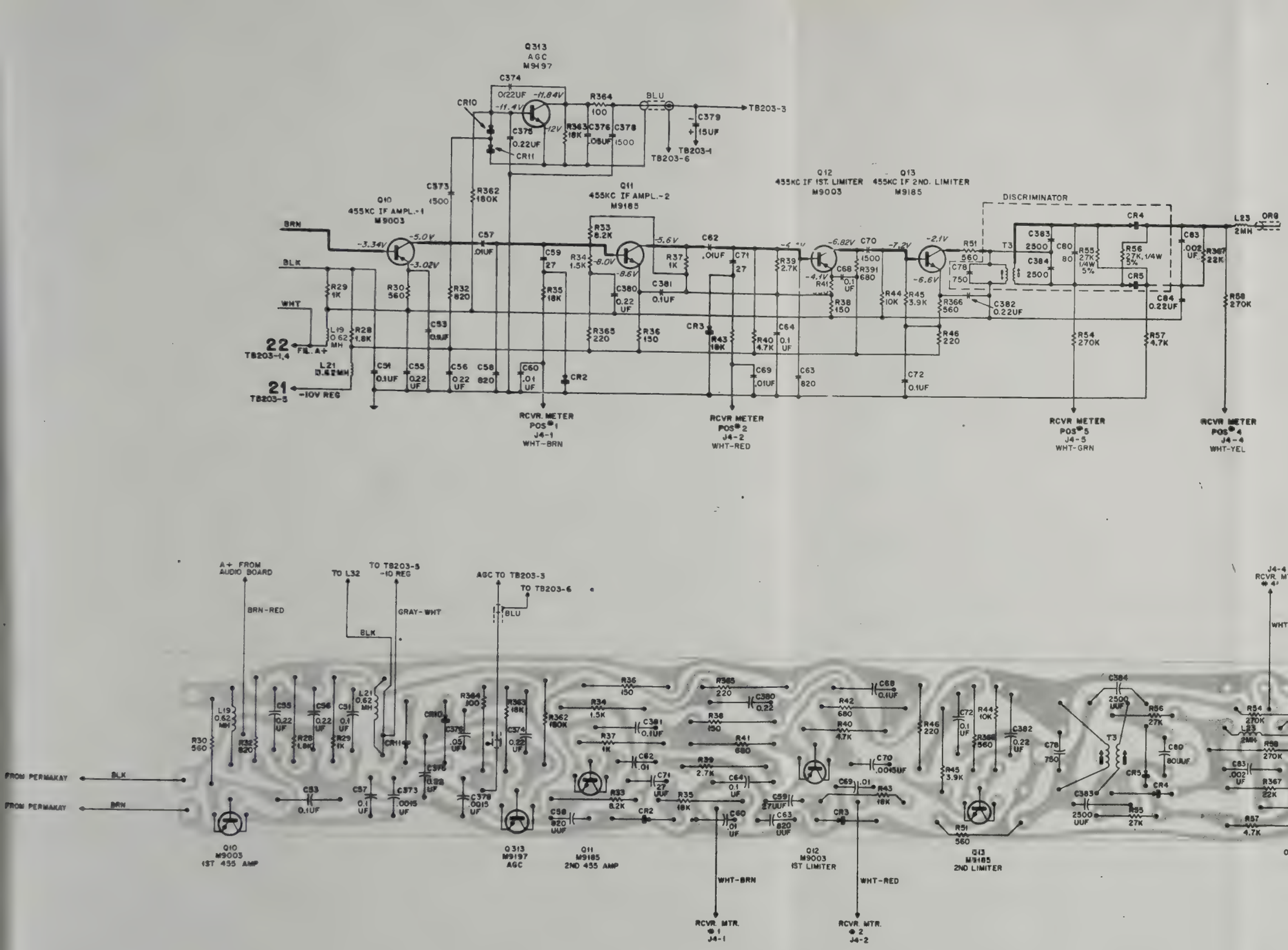
B	TLN6623-B		ADDED 68P81022A65	DIAGRAM BOOKLET LIST
C	TLN6623B	C64	WAS 8D82905G11, 0.22 uuf	LEFT OF Q12
		C380	WAS 8D82905G07, 0.1 uf	ABOVE Q12
D	TLN6623B	Q313	WAS 48R869196 TYPE M9196	A.G.C.
E	TLN6623B-2	C390	ADDED 1500 uuf	DISCRIMINATOR
F	TLN6623B-3	C390	REMOVED 21D82187B11 1500 uuf CIRCUIT WAS AS SHOWN BELOW	LOWER RIGHT OF CKT. BD.



G	TLN6623B-4	C57, 60, 62, 69	WERE 21D82428B12, .01 uf -70-30%; 100 V	PARTS LIST

TLN6623B 455 KC IF Amplifier Board EPD-9981-G

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uuf; unl. stated
C51, 54, 61, 66, 72	[illegible]	0.1 uf ±10%; 25 v
C55, 56, 84, 374, 375, 381, 382	8D82905G11	.22 ±10%, 25 v
C57, 60, 62, 69	21D82428B58	.01 uf +80-20%; 500 v
C58, 63	21C82187B17	820 ±10%; 500 v
C59, 71	21D82133G06	27 ±5%; 500 v; NP0
C70, 373, 378	21C82187B18	1500 ±10%; 100 v
C78	21K848159	750 ±10%; 300 v
C80	21D82133G28	80 ±10%; N1500
C83	21D82428B25	.002 uf ±20%; 20 v
C376	21C82372C04	.05 uf +80-20%; 25 v
C383, 384	21K859773	2500 ±5%; 500 v
		SEMICONDUCTOR DEVICE, diode: SEE NOTE 1
CR2, 3	48C82921G01	germanium
CR4, 5	48C82130G01	germanium
CR10, 11	48C82394B03	silicon
		COIL, RF: choke:
L19, 21	24D82135G01	0.62 mh
L23	24D82135G07	2.0 mh
		TRANSISTOR: SEE NOTE 1
Q10, 12	48R869003	P-N-P; type M9003
Q11, 13	48R869185	N-P-N; type M9185
Q313	48R869197	N-P-N; type M9197
		RESISTOR, fixed: ±10%; 1/2 w; unl. stated
R28	6R2089	1.8K
R29, 37	6R6229	1K
R30, 51, 366	6R6291	560
R32	6R6269	820
R33	6R2004	8.2K
R34	6R6038	1.5K
R35, 43, 363	6R5591	18K
R36, 38	6R6373	150
R39	6R5577	2.7K
R40, 57	6R6080	4.7K
R41, 391	6R6040	680
R44	6R6320	10K
R45	6R5659	3.9K
R46, 365	6R6270	220
R54, 58	6R6414	270K
R55, 56	6K129886	27K ±5%, 1/4 w
R362	6R6444	180K
R364	6R6326	100
R367	6R6397	22K
		TRANSFORMER,
T3	24V80902A86	incl. 76K855159 CORE, tuning 2 req'd
NON-REFERENCED ITEMS		
	1V80737A31	CIRCUIT BOARD ASSY. (eyeleted)
	26A82451G03	SHIELD, coil



PREVIOUS REVISIONS SHOWN
ON BACK OF THIS DIAGRAM

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455 KC IF Circuit Board Detail
Model TLN6623B-4 used in
152-162 MC, 20 W, ±12 V DC
Motorola Car Telephone Receiver
Motorola No. EPD-9981-G (MR-2115B)
2/8/67-

MOTOROLA

INSTRUCTION MANUAL REVISION MR-2421

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUAL(S) AFFECTED:

152-162 MC Car Telephone Radio Set

REVISION DETAILS

With this change the following becomes effective:

Instruction Manual No.	Schem. Diag. & New Issue	Unified Chassis	New Suffix
68P81022A65	63E81022A67-N	TUD1160AB	5
68P81045A70			
68P81056A85-O	63E81056A86-B	TUD1240AB	2

(1) Component Changes

Ref Sym	Action	Part Number	Description
C86	Added	21K801139	CAPACITOR, fixed: .01 uf +80-20%; 600 V; SEE WIRING CHANGE

(2) Wiring Changes

C86 (.01 uf) is connected between terminal 4 and terminal 11 of J102

p/o 68P81022A65

CONTENTS

Control Number	EPD-10673
Transmitter Alignment and "IDC" Adjustment Procedure	EPD-10229/EPD-10230
Receiver Alignment Procedure	EPD-9923
Diplexer Alignment Procedure	EPD-9920
Radio Set Schematic Diagram and Parts List	63E81022A67
Supervisory Unit Schematic Diagram and Parts List	63E81021A27
Control Head Schematic Diagram and Parts List	63D81021A77
Control Head Schematic Diagram and Parts List (Revertive)	63D81021A87
Cable Kit Schematic Diagram and Parts List	63D81022A79
Circuit Board Location Details	BEPD-10443
Audio-First Oscillator Multiplier Circuit Board Detail and Parts List	EPD-9975
5.26 MC IF Circuit Board Detail and Parts List	EPD-10088
2nd Oscillator Circuit Board Detail and Parts List	EPD-8828
455 KC Filter Amplifier Circuit Board Detail and Parts List	EPD-10093
455 KC IF Circuit Board Detail and Parts List	EPD-9981
Channel Element Oscillator Circuit Board Detail and Parts List	EPD-8737
Oscillator Module Socket Board Detail and Parts List	EPD-9972
Power Supply and Regulator Circuit Board Details and Parts List	EPD-8782
Audio-Exciter Circuit Board Details and Parts List	EPD-9978
Control Circuit Board Detail and Parts List	EPD-10268
Control Circuit Board Detail and Parts List	EPD-13150
Oscillator and Detector Circuit Board Detail and Parts List	EPD-10276
Selector Circuit Board Detail and Parts List	EPD-10272
Switching Circuit Timing Chart	EPD-8742
Mobile To Base Tone Sequence Chart	EEPD-9489
Base To Mobile Tone Sequence Chart	EEPD-9490
Mobile To Base Timing Chart	EEPD-9485
Base To Mobile Timing Chart	EEPD-9486
Mobile Disconnect Timing Chart	EEPD-9488
Mobile Dialing Timing Chart	DEPD-9487
Instruction Manual	68P81021A15

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EPD-11607-A

MOTOROLA

INSTRUCTION MANUAL REVISION MR-2421

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUAL(S) AFFECTED:

152-162 MC Car Telephone Radio Set

REVISION DETAILS

With this change the following becomes effective:

Instruction Manual No.	Schem. Diag. & New Issue	Unified Chassis	New Suffix
68P81022A65	63E81022A67-N	TUD1160AB	5
68P81045A70			
68P81056A85-O	63E81056A86-B	TUD1240AB	2

(1) Component Changes

Ref Sym	Action	Part Number	Description
C86	Added	21K801139	CAPACITOR, fixed: .01 uf +80-20%; 600 V; SEE WIRING CHANGE

(2) Wiring Changes

C86 (.01 uf) is connected between terminal 4 and terminal 11 of J102

MOTOROLA

INSTRUCTION MANUAL REVISION MR-24

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUAL(S) AFFECTED:

152-162 MC Car Telephone Radio Set

REVISION DETAILS

With this change the following becomes effective:

Instruction Manual No.	Schem. Diag. & New Issue	Unified Chassis	New Suffix	Ckt. Bd. Detail	New Issue	Ch Iter
68P81022A65	63E81022A67-P	TUD1160AB	6	EPD-10088	H	
68P81045A70				EPD-9975	F	
68P81056A85-O	63E81056A86-C	TUD1240AB	3	EPD-21532	A	
				EPD-21592	A	

Component Changes

Change Item No.	Ref. Sym.	Action	Part Number	Description
1	Q8	Changed to	48R869204	TRANSISTOR, P-N-P: type M9404
2	Q4	Changed to	48R869425	TRANSISTOR, P-N-P: type M9425

MOTOROLA

INSTRUCTION MANUAL REVISION SMR-333

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUALS AFFECTED:

68P81022A65 152-162 MC IMTS Car Telephone FM Radio
68P81043A85 152-162 MC MTS Car Telephone FM Radio

REVISION DETAILS

With this change the following becomes effective:

In the Model Chart of the above Instruction Manuals, change the Antenna Model for Radio Set Models T1231CH, T1233CH, T1262AH and T1279AH from TAD6120A to TAD6113A.

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUALS AFFECTED:

152-162 MC Car Telephone Radio Set

REVISION DETAILS

With this change the following becomes effective:

Instruction Manual No.	Schem. Diag. & New Issue	Exciter Bd. & New Suffix	Ckt. Bd. Detail	New Issue
68P81022A65, 68P81045A70	63E81022A67-R	TLD6300B-4	EPD-9978	G
68P81056A85-O	63E81056A86-D			

Component Changes

Ref. Sym.	Action	Part No.	Description
R105	Changed to	6R5652	RESISTOR, fixed: 2.7K ±5%; 1/2 w
R106	Changed to	6S125A54	RESISTOR, fixed: 1.6K ±5%; 1/2 w
R109	Changed to	6S125A16	RESISTOR, fixed: 43 ±5%; 1/2 w
R110	Changed to	6R2003	RESISTOR, fixed: 3.3K ±5%; 1/2 w

MOTOROLA

INSTRUCTION MANUAL REVISION SMR-400

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUALS AFFECTED:

152-162 MC Improved Mobile Telephone System

REVISION DETAILS

With this change the following becomes effective:

Instruction Manual No.	Schem. Diag. & New Issue	2nd Osc. & New Suffix	Ckt. Bd. Detail	New Issue	Change Item No.
68P81022A65 68P81043A85 68P81045A70	63E81022A67-S	TLN6624A-2	EPD-8828	J	1
		1st Osc. Multi. & New Suffix			
		TLN6622B-5	EPD-9975	G	2

Component Changes

Change Item No.	Ref. Sym.	Action	Part No.	Description
1	R22	Changed to	6S5726	RESISTOR, fixed: 15K ±5%; 1/2 w
2	C98	Changed to	21D82187B32	CAPACITOR, fixed: 150 uuf ±10%; 500 v

MOTOROLA

INSTRUCTION MANUAL REVISION SMR-425

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUALS AFFECTED:

152-162 MC IMTS Car Telephone FM Radio

REVISION DETAILS

With this change the following becomes effective:

Instruction Manual No.	Schem. Diag. & New Issue	Unified Chassis & New Suffix	Ckt. Bd. Detail	New Issue
68P81022A65 68P81043A85 68P81045A70	63E81022A67-T	TUD1160AB-6	EPD-8782	J
68P81056A85-A	63E81056A86-E	TUD1240AB-3	EPD-21537	B

Component Changes

Ref. Sym.	Action	Part No.	Description
C205, 206, 207	Changed to	23D83550B02	CAPACITOR, fixed: 50 uf +150-10%; 25 v

CONTROL NUMBER

The control number consists of a group of suffix numbers which are used to identify production changes in the equipment. These suffix numbers are in three groups, stamped on (1) the radio set, (2) the supervisory unit and (3) the various kits, units, etc., which comprise the accessories. The suffix numbers and corresponding revisions are indicated on the applicable diagrams permitting correlation between the diagrams and equipment.

LOCATION OF CONTROL NUMBER STAMP

Radio Set - right side on top of chassis near rear heat sink.

Supervisory Unit - chassis plate under the model numbers.

All other kits - prominent location on chassis, housing or packaging.

The information in this manual is applicable to equipment where the suffix numbers are the same or lower than those shown in the adjacent table. The control numbers consist of suffix numbers in the sequence shown. It should be noted that when the suffix is "00" it is not usually stamped on the kit. When the suffix is "01" or "02", it is usually stamped "1" or "2", etc.

RADIO SET CONTROL NUMBER

Model No.	Description	Suffix
TFN6018AS	455 KC Filter Ampl.	00
TLD6290B	RF Deck	01
TLD6300B	Audio-Exciter Bd.	03
TLN6619B	Chassis Component Kit	03
TLN6620B	Osc. Module Socket Bd.	02
TLN6621B	5.26 MC IF Bd.	03
TLN6622B	Audio, 1st Osc & Mult Bd	03
TLN6623B	455 KC IF Bd.	04
TLN6624A	2nd Osc. Bd.	01
TLN6625A	Power Ampl.	00
TLN6627B	Unit Component Kit	02
TLN6628B	Diplexer Kit	00
TPN6046A	Power Supply Bd.	02

SUPERVISORY UNIT CONTROL NUMBER

Model No.	Description	Suffix
TKN6171A	Intercabling Kit	02
TLN6814A	Selector Bd.	02
TLN6815A	Osc. & Detector Bd.	05
TLN6816A	Control Bd.	05

INDIVIDUAL KIT CONTROL NUMBER

Model No.	Description	Suffix
TCN6060A	Control Head (Bell)	00
TCN6070A	Control Head (Non-Rev.)	00
TCN6090A	Control Head (Rev.)	00
TLD1010A	Series Chan. Elem.	00
TKN6142B	Cable Kit (Neg Gnd)	00
TKN6178A	Cable Kit (Pos Gnd)	00
TLN6928A	Chan. By-Pass Elem.	00
TLN6902A	Hardware Kit	00

TRANSMIT PRE-ALIGNMENT NOTES

EXCERPTS FROM FCC REGULATIONS

FCC regulations state that:

1. Radio transmitters may be tuned or adjusted only by persons holding a 1st or 2nd class commercial radiotelephone operator's license or by personnel working under their immediate supervision.
2. The r-f power output of a radio transmitter shall be no more than that required for satisfactory technical operation considering the area to be covered and the local conditions.
3. Frequency and deviation of a transmitter must be checked before it is placed in service and rechecked once each year thereafter.

TEST EQUIPMENT REQUIRED

1. Motorola Model S1056A-9A Portable Test Set with a Motorola Model TEN6055A Test Set Adapter (available on separate order). A 0-50 microampere meter with 20,000 ohms equivalent series resistance may be used if a test set is not available.
2. Motorola Model TLN6629B Tuning Tool Kit. (A dial screwdriver is also useful.)
3. Bird "Termaline" Model 612 Wattmeter (or equivalent).
4. Motorola Model T1012A Power Supply (or equivalent) with TEK-15A Ripple Filter.
5. Motorola Model S1068A Frequency Calibrator or Motorola Model T1130A FM Station Monitor. NOTE: When using the Model T1130A FM Station Monitor the output frequency of the transmitter must be measured with the radio set at room temperature (72° - 80°F).

HOW TO SET UP THE S1056A-9A PORTABLE TEST SET

1. Set function selector switch to XMTR, position.
2. Place the oscillator and meter reversing switch in the OFF position.
3. Connect the 20-pin meter cable plug to the test set; connect the other end of the test set metering cable to the 11-pin female receptacle on the test set adapter (TEN6055A); place the metering selector switch on the test set adapter to the XMTR METERING position; connect the metering cables extending from the test set adapter to the metering receptacles located behind the nameplate cover on the front panel of the radio set. Note: Make certain that the cable being connected is plugged into the appropriate metering receptacle as indicated by the designations on the nameplate cover. When the test set is not being used, disconnect the 20-pin meter cable plug from the test set to conserve internal battery life. The plug on the cable acts as an on-off switch completing the battery circuit.

HOW TO KEY THE TRANSMITTER

Key the transmitter with the XMTR switch on the test set adapter, or by depressing the push-to-talk button on the control head handset or test handset connected into the test set adapter (if installed).

CAUTION

Do not key the transmitter for more than a few seconds at a time until it is properly tuned. Plate current is excessive in untuned stages and may cause damage. Turn on the transmitter for brief periods while reading the meter and making the adjustments.

CRYSTAL FREQUENCY CALCULATIONS

xtal freq. in mc $\rightarrow f_o = \frac{f_c}{12} \leftarrow$ carrier freq. in mc (known)

"IDC" CONTROL SETTING

(Transmitter Deviation)

Refer to the reverse side of the transmitter alignment chart for setting of the IDC control.

PRELIMINARY ADJUSTMENTS

1. Connect the dummy load or r-f wattmeter to the front panel antenna receptacle.
2. Turn the equipment on and allow at least 60 seconds for warm-up.

TRANSMITTER ALIGNMENT

STEP	ADJUSTMENT	TEST SET SWITCH POSITION	STAGE AND TUNING PROCEDURE
1	---	None	NOTE: The radiotelephone units as shipped from the factory, have been aligned on the center frequency channel (YK). If retuning becomes necessary, the radio set should be aligned on any one channel selected by the following order of preference: YK or JS or YJ or -- YS, YP, YR, JP,, JK, YL, JR, JL.
2	---	None	OSCILLATOR. FCC regulations require a periodic frequency check. If the check is due at this time, follow the procedure on the reverse side of this sheet; OTHERWISE NO ADJUSTMENT SHOULD BE MADE.
3	L301	3 (Rcvr)	MODULE BOARD LIMITER OUTPUT. Place the metering selector switch on the test set adapter to the RCVR METERING position. Place the function selector switch on the portable test set to the RCVR position. Key the transmitter and, using tuning tool A, adjust L301 for a maximum meter indication. Use the peak obtained when the slug is positioned near the top of the coil form.
4	L103	3 (Xmtr)	FIRST DOUBLER COLLECTOR. Set up the portable test set as described in paragraph "HOW TO SET UP THE S1056A-9A PORTABLE TEST SET." Turn the slugs in L103, L104, and L105 (using tuning tool A) counterclockwise until the slugs appear just above the top of the coil forms. Adjust tune for a peak meter reading.
5	L104	3 (Xmtr)	AMPLIFIER INPUT. Tune L104 for a peak meter reading.
5a	L105	4	AMPLIFIER OUTPUT. Adjust L105 for a peak reading and then detune this coil by turning the slug clockwise three full turns.
5b	L104	3 (Xmtr)	AMPLIFIER INPUT. Adjust L104 for a peak reading. Do not peak L104 again.
6	L105	4	AMPLIFIER OUTPUT - TRIPLER GRID. Adjust L105 for a peak meter indication. Do not tune L105 again. NOTE If it becomes necessary to retune or repeak the radio, steps 4 thru 6 must be repeated.
7	T101	5	TRIPLER PLATE-DOUBLER DRIVER GRID. Use tuning tool A. Turn the bottom slug of transformer T101 clockwise and the top slug counterclockwise until each slug appears just out of the coil form. Starting with the top slug, alternately turn each slug approximately two turns into the coil form. Continue this alternate tuning procedure until a peak meter reading is obtained.
8	L108 C141	6	DOUBLER DRIVER PLATE-PA GRID. Use tuning tool C. Turn PA GRID COUPLING (L108) fully counterclockwise (maximum coupling). Using hex tool A tune DRIVER PLATE C141 for a peak meter reading. Now turn the grid coupling adjustment in a clockwise direction until the meter indication decreases about five microamperes. Readjust C141 for a maximum meter reading. If the obtained reading is greater than the original reading, continue aforementioned procedure until a maximum indication is obtained.
9	L110 C148	7	PA PLATE. Use tuning tool C or the dial screwdriver. Set the ANT. COUPLING adjustment (L110) to a maximum counterclockwise position (minimum coupling). Adjust the PA PLATE tuning capacitor (C148) for a minimum plate current reading (12 to 14 ua) on the test set meter, using hex tuning tool A. Do not readjust.

NOTE: Using a 7/16-inch socket wrench, depress the funnel spring and loosen the locknut on L110.
IMPORTANT: Retighten locknut before completing tuning.

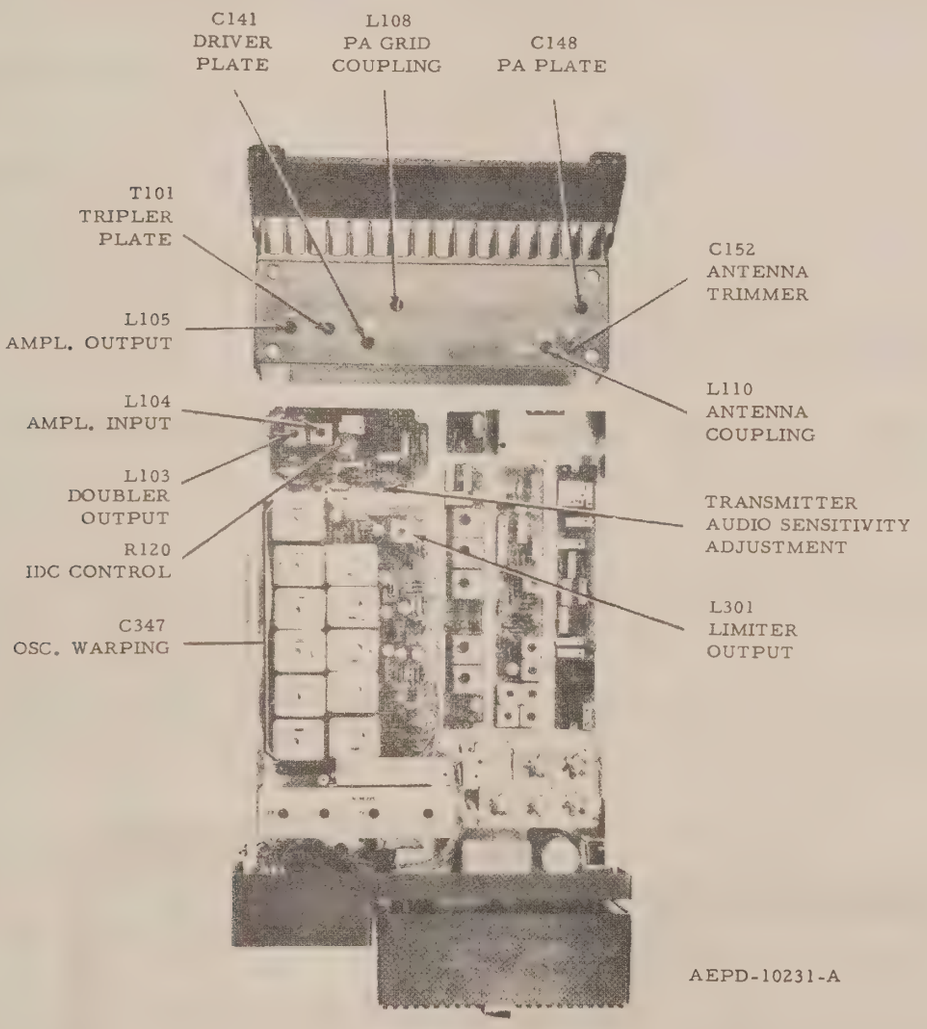
STEP	ADJUSTMENT	TEST SET SWITCH POSITION	STAGE AND TUNING PROCEDURE
10	L110 C152	7	RF OUTPUT WORKING INTO DUMMY LOAD OR LOADING INTO ANTENNA USING THRULINE WATTMETER. Increase the antenna coupling until the wattmeter displays an indication of approximately 10 watts. Adjust the antenna trimmer for a maximum power output indication. Alternately adjust the antenna coupling and antenna trimmer until 20 watts of power output is obtained without exceeding a PA CURRENT of 200 ma (40 ua on the test set meter). Loading into antenna method (emergency only-not recommended): Unload the transmitter and adjust the PA PLATE tuning capacitor for a minimum plate current reading as outlined step 9. Increase the antenna coupling (clockwise adjustment) to obtain a plate current increase of about 5 ua (25 ua). Use tuning tool A or the dial screwdriver. Adjust the ANT TRIM. (C152) for a maximum indicated plate current indication and then readjust the antenna coupling, if necessary for a plate current of 35 ua (175 ma) or slightly less with the antenna trimmer peaked. Increase the antenna coupling 2 to 3 microamperes. Adjust the antenna trimmer noting the effect on the indicated plate current. If the plate current decreases when the antenna trimmer is adjusted in either direction of rotation, the coupling can be increased further. Continue this procedure of increasing the antenna coupling (using 2 to 3 microampere steps) and adjusting the antenna trimmer noting the effect on the plate current. When the plate current decreases, adjusting the antenna trimmer in one direction of rotation, and increases, in the other direction of rotation, the transmitter is overcoupled. When this occurs unload the transmitter slightly (counterclockwise rotation of L110) and repeak the antenna trimmer. (Refer to Note in Step 9.) Optimum coupling should occur before reaching 200 ma (40 ua on the test set meter).
11	Repeat steps 4 thru 8		FINALIZING ADJUSTMENTS: Carefully repeak all adjustments (steps 4 thru 8). Check the power output on each channel. The power output must be 20 watts minimum on all channels with the battery or supply voltage set at 13.6 v d-c. NOTE: If the above results are not obtained increase the antenna coupling slightly until the minimum power output is indicated on all channels.

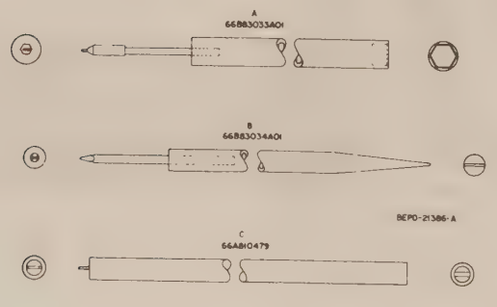
FINAL METER READING

1. Each time a transmitter is aligned or tested, final meter readings should be made and entered in a logbook.
2. All readings given in the following table are minimum except PA which is maximum. DO NOT exceed the value given for the PA current. This is maximum plate current to which the unit can be safely tuned. Multiply the microampere scale reading by 5000 to obtain actual PA plate current in milliamperes.
3. Readings 3 through 6 are purely relative and do not give actual current or voltage measurements.

CIRCUIT METERED	AMPLIFIER BASE	TRIPLER GRID	DOUBLER DRIVER GRID	PA GRID	PA PLATE CURRENT	PA PLATE VOLTAGE
SWITCH POSITION*	3	4	5	6	7	9
METER READING 20 W	10	10	20	15	40	300 v d-c (nominal)

* PO position reads same as position 1; do not use for power output.





OSCILLATOR FREQUENCY ADJUSTMENT

Setting the oscillator "on-frequency" is the only oscillator adjustment necessary. Do this as follows.

1. Standard Method:

a. Set up the frequency calibrator as described in the frequency calibrator instruction manual.

b. Insert the channel element modules supplied with the radio set into the receptacles provided on the frequency calibrator.

c. Adjust the oscillator warping capacitor (C347) for a zero beat.

2. Alternate Method:

a. Set up the frequency monitor as described in the frequency monitor instruction manual. Place the monitor antenna within a few feet of the transmitter.

b. Plug the selected channel element into the socket and set MON. CHANNEL SELECTOR to corresponding position. Follow standard monitoring procedure.

c. Adjust C347 for zero reading on the monitor CARRIER FREQUENCY meter with the switch in corresponding position.

d. After setting the transmitter "on-frequency" remove the corresponding plug-in channel element in the radio set. The frequency monitor should indicate no transmitter output. Replace the chan nel element and proceed with alignment.

"IDC" ADJUSTMENT (PREFERRED METHOD USING OSCILLOSCOPE)

1. INTRODUCTION

Accuracy of test equipment is of prime importance to any user of radio communications equipment; but of equal importance is a knowledge of the characteristics of the measuring equipment under various conditions. The Motorola T1130A Series FM Station Monitor is the leader in the field with respect to sensitivity, accuracy under conditions of variation in r-f signal level, line voltage, and environmental conditions. In common with most other meters it has the characteristic of responding differently to different wave shapes. Therefore, the use of most present-day deviation meters can lead to confusion and errors in deviation setting, if the pitfalls are unknown or disregarded.

The ideal deviation indicator would be one which would respond instantaneously to the peak value of the modulation deviation regardless of waveform. The only device which meets all these requirements is an oscilloscope. It responds instantaneously and it shows the peak value of any waveform, no matter how complex. Properly calibrated, an oscilloscope is the most accurate and reliable instrument for measuring and setting transmitter deviation.

The oscilloscope must be used in conjunction with a receiver which has a stable discriminator characteristic, since the oscilloscope displays the demodulated signal. In addition to the oscilloscope and receiver, a means to accurately calibrate the system is required. The Motorola monitor fills these requirements, since it provides both a sensitive receiver with the proper discriminator characteristic and a reliable means of calibrating the oscilloscope. It has convenient terminals on the front panel for connection of the oscilloscope.

Split-channel conversion kits are available for modification of older models. When converted, the older models have convenient oscilloscope terminals and can be more accurate measurement devices for such systems.

2. TEST EQUIPMENT REQUIRED

a. Motorola T1130A Series FM Station Monitor (or equivalent).

b. Motorola Transistorized AC Voltmeter (or equivalent).

c. Motorola Model TEK-31 Transistorized Tone Generator, 1000 cps (or equivalent).

d. Motorola Model T1014B Precision Wide Band or T1015A General Purpose Oscilloscope (or equivalent)

e. Motorola Model S1056A-9A Portable Test Set with Motorola Model TEN6055A Test Set Adapter

3. OSCILLOSCOPE CALIBRATION

The first step in the measurement of transmitter deviation is to calibrate the oscilloscope. This can be done by using the transmitter which is to be measured.

Proceed as follows:

a. Connect the oscilloscope to the monitor oscilloscope terminals and set up the monitor controls in accordance with the monitor instruction manual.

b. Turn the IDC control on the transmitter chassis to the full clockwise position.

c. Feed a 1000 cps tone from the Motorola Model TEK-31 Transistorized Tone Generator into the XMTR AUDIO INPUT terminals on the test set adapter. Follow the procedure outlined in the instructions supplied with the test set adapter. Modulate the transmitter with this tone so adjusted that the deviation as read on the FM monitor deviation meter is 2 kc.

d. Adjust the vertical gain of the oscilloscope so that the total recovered audio pattern occupies some convenient height, e.g., four small squares as shown in figure 1.

Having calibrated the oscilloscope, there is no further need for the modulation deviation meter. Ignore its reading from this point on. It has already performed its important function of calibrating the oscilloscope.

With the oscilloscope calibrated as indicated, a recovered signal which occupies 10 squares (peak-to-peak) is equivalent to ±5 kc deviation. For wide-band systems a recovered signal occupying 30 squares (peak-to-peak) is equivalent to ±15 kc deviation.

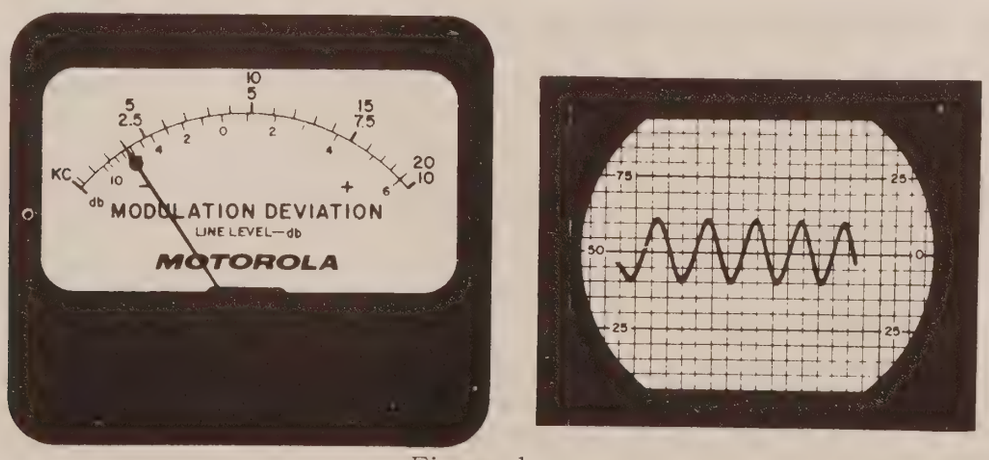


Figure 1

Oscilloscope Calibration for Transmitter

4. MEASUREMENT AND SETTING OF TRANSMITTER DEVIATION

Once the oscilloscope has been calibrated, the transmitter deviation can be properly adjust the following method.

a. Adjust the 1000 cps input signal to approximately 1.0 volt. See figure 2.

b. With this input signal level, adjust the IDC Control on the transmitter to provide a 10-squa peak-to-peak recovered signal on the oscilloscope. This is equivalent to ±5 kc deviation a shown in figure 2.

c. Reduce the 1000 cps input until ±3.3 kc deviation is observed on the oscilloscope (6.6 squa peak-to-peak). The 1000 cps input is dependent on the sensitivity setting and should be b tween the limits indicated in figure 3.

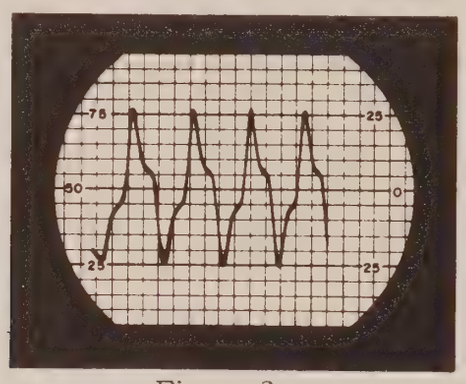


Figure 2

5 KC Peak Deviation as seen on the Oscilloscope
(NOTE: Waveform is clipped fully, audio sensitivity adjustment set at maximum.)

5. EMERGENCY MEASUREMENT OF DEVIATION

If an audio oscillator is not available, a loud sustained whistle of approximately 1000 cycles be used for a rough measurement of deviation. If this rough check indicates the need for resett deviation, do so only under controlled conditions, using a 1000 cps tone as previously indicated. calibration of the oscilloscope should always be performed with a steady controlled signal. Do attempt to calibrate the oscilloscope with a sustained whistle as waveform distortion will preve accurate calibration.

6. OTHER MEANS FOR MEASUREMENT OF DEVIATION

Another accurate means of measuring transmitter deviation is to use the Motorola T1021A quency Meter and the Motorola S1058A or S1059A Portable Test Set (with deviation meter). Thi unit, properly used, permits the accurate measurement and setting of transmitter deviation fro peak-reading meter, which is unaffected by waveform. An oscilloscope is not required with thi strument. With this device, the transmitter deviation can be measured accurately even with the voice modulation.

7. MICROPHONE LEVELS

If the modulation level in the system still appears to be too low after setting deviation as in ted above, check the handset. An audio sensitivity adjustment is also provided (four connecting minals and a jumper wire) for setting the sensitivity of the audio amplifier. This adjustment is cluded for speech level and handset output compensation.

The foregoing procedure will insure that the transmitter will comply with FCC requirement maximum deviation.

The importance of the correct deviation setting can not be overemphasized. Optimum syste performance demands accurate deviation setting, both from the standpoint that overdeviation wi interfere with the user on the adjacent channel, and underdeviation may reduce system range.

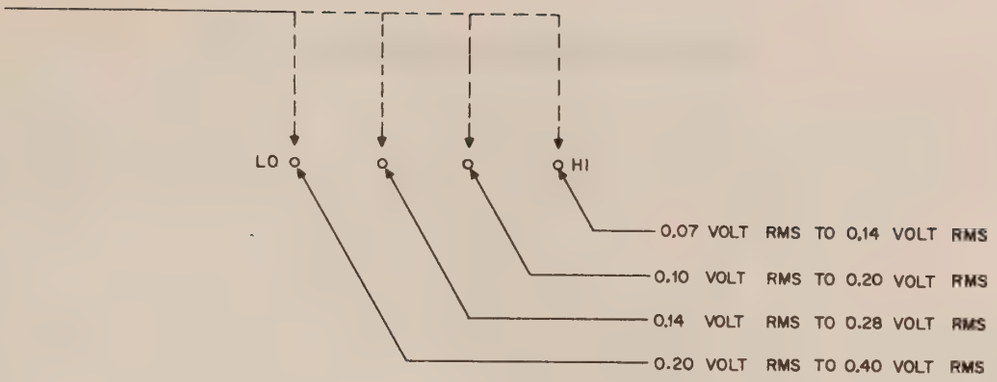


Figure 3
Sensitivity Setting

A. TEST EQUIPMENT REQUIRED

1. Motorola Model S1056A-9A Portable Test Set should be used. A 0-50 microampere meter with 20,000 ohms equivalent series resistance may be used if a test set is not available.
2. Motorola Model T1034C Signal Generator or i-f test set has peaking generator, complete r-f alignment can be accomplished with a YK channel element and a type AUL 7269.524 kc crystal (for generating 152.660 mc).
3. Motorola Model TLN6629B Tuning Tool Kit. (A small screwdriver may be used for some of the alignment.)
4. Motorola Model T1012A Power Supply or equivalent, with TEK-15A Ripple Filter.
5. Motorola Model TEN6055A Test Set Adapter.
6. Motorola Model TEN6054B Alignment Cable Kit.

B. HOW TO SET UP THE S1056A-9A PORTABLE TEST SET

1. Set function selector switch to RCVR position.
2. Place the metering selector switch on the test set adapter (TEN6055A) to the RCVR METERING position and XMTR switch to OFF.
3. Switch on 455 kc crystal oscillator.
4. Connect the 20-pin meter cable plug to the test set; connect the other end of the cable to the 11-pin female receptacle on the test set adapter; connect the metering cables extending from the test set adapter to the metering receptacles located behind the nameplate cover on the front panel of the radio set. Note: Make certain that the cable being connected is plugged into the appropriate metering receptacle as indicated by the designations on the nameplate cover. When the test set is not being used, disconnect the 20-pin metering cable from the test set to conserve internal battery life. The plug on the cable acts an on-off switch completing the battery circuit.
5. Connect the r-f extension cable to the test set; connect the r-f probe cable to the r-f extension cable.

C. HOW TO SET UP THE SIGNAL GENERATOR FOR 5.26 MC IF ALIGNMENT

1. Set up the signal generator or test set according to the instructions supplied with the unit (test set requires type AUL 5.26 mc crystal).
2. Connect the signal generator or test set to the TEK-10 RF Cable Adapter supplied with the Motorola Model TEN6054B Alignment Cable Kit.
3. Connect the probe on the r-f cable adapter to POINT 2 (First Mixer Base) as shown on the photo.
4. Switch the position selector switch on the portable test set to position 4.
5. Rotate the signal generator dial back and forth near the 5.26 mc reading. Watch the test set meter. The pointer should swing above and below the zero reading as the dial is rotated. Set the dial to absolute zero meter reading.

D. HOW TO SET UP THE SIGNAL GENERATOR FOR RF ALIGNMENT

1. Set up the signal generator or peaking generator according to the instructions supplied with the unit.
2. Connect the signal generator or peaking generator cable to the antenna input.
3. Turn the generator output up to maximum.
4. Keep the test set in position 4.
5. Rotate the signal generator dial back and forth near the assigned r-f carrier frequency. Watch the test set meter. The pointer should swing above and below the zero reading as the dial is rotated. Set the dial for exact zero meter reading. Be sure the generator frequency is kept at zero meter reading.

E. FREQUENCY CALCULATIONS

$$f_1 = \frac{f_c + 5.26 \text{ mc}}{12}$$

where: f_1 = 1st oscillator frequency

and

f_c = carrier frequency

$$f_2 = 5260 \text{ kc} + 455 \text{ kc}$$

where: f_2 = 2nd oscillator frequency

F. TEST SET SELECTOR SWITCH POSITIONS

1056A-9A EST SETS	1	2	4	5	6	11
IRCUIT IETERED	455 KC IF Ampl. #1	455 KC IF Ampl. #2	Discrim. Secondary	Discrim. Primary	Osc. Mult.	Audio

G. RECEIVER ALIGNMENT

STEP	STAGE AND PROCEDURE
	NOTE: The following steps outline the procedure for complete realignment of the receiver. After normal maintenance and repair, realignment can be accomplished by peaking adjustment on position 1 or 2 using the signal generator or peaking generator as a signal source at the antenna connector.
1	DISCRIMINATOR PRIMARY -- Set up the test set as described in paragraph B at the left. Insert a 2 uuf capacitor in series with the r-f probe. Place the r-f probe on the input to the 455 kc i-f board (Point 1). Use the hex end of tuning tool A. Adjust both slugs of T3 so they are half way out of the coil form. Tune T3 (bottom slug) for a peak reading on position 5 at the peak nearest the bottom of the coil.
2	DISCRIMINATOR SECONDARY -- With the test set connected as described in step one above, use the hex end of tuning tool A to adjust the top slug of T3 for absolute zero on the center (top) scale with the selector switch in position 4. This is a critical adjustment and should be exactly on zero. Remove the probe from Test Point 1.
3	5.26 MC IF -- Set up the test equipment as described in paragraph C at the left. Use the minimum 5.26 mc signal that will produce a linear increase in the test set meter reading with an increase in signal strength (selector switch in position 1). Tune L14, T1, T2, L15 and L16 in that order, for a maximum test set meter indication with the selector switch in position 1. Use tuning tool B. When tuning the slugs for a maximum reading, two peaks will be obtained. Use the peak obtained when the slug is positioned near the bottom of the coil. Repeak all coils using the above sequence. Note: If there is no meter indication on position 1, use position 2 until a reading is obtained on meter position 1. Same indication may be seen on position 2 when using the test set when the slugs are detuned. This is due to radiation. Follow the tuning procedure until a definite increase in position 1 or 2 is seen for adjustment of the slugs.
4	FIRST OSCILLATOR -- Refer to step 2 in the Transmitter Alignment Procedure. Do not repeat the procedure if previously performed for transmitter alignment.
5	12x MULTIPLIER BOARD -- Use tuning tool A to position the coil slugs of L24 through L30 flush with the tops of their coil cams. Tune L24, L25 and L26 in that order two turns at a time until a meter indication in position 6 is obtained. Then adjust L24, L25 and L26 for a maximum meter indication in position 6. Connect the peaking generator or signal generator to the TEK-10 RF Cable Adapter supplied with the Model TEN6054B Alignment Cable Kit. Connect the probe to Point 2 (First Mixer Base). With the generator set at f_c alternately follow steps 3, 4 and 5 of paragraph D at the left and tune L27, L28, L29 and L30 in that order two turns at a time until a meter indication in position 4 is obtained. Then adjust L27, L28, L29 and L30 for a maximum meter indication in position 2. When tuning the slugs for a maximum reading, two peaks will be obtained. Use the peak obtained when the slug is positioned near the top of the coil form, for all coils.
6	RF DECK -- Set up the peaking generator or signal generator as described in paragraph D at the left. Using tuning tool C, turn the tuning screws of L1 through L5 fully counterclockwise. Turn L1, L2, L3, L4 and L5, in that order clockwise one turn at a time. Repeat until a meter indication is obtained in position 2. Using the above sequence adjust each screw to a point slightly beyond the maximum meter indication in position 2. Following the above sequence turn each screw counterclockwise until a peak meter reading is obtained in position 2. Use tuning tool B to tune L6 for a maximum meter indication in position 2. Use the peak for L6 that occurs nearest the bottom of the coil. Repeat the peaking adjustment for L1 through L6. Retune L30 for a peak reading in position 2.

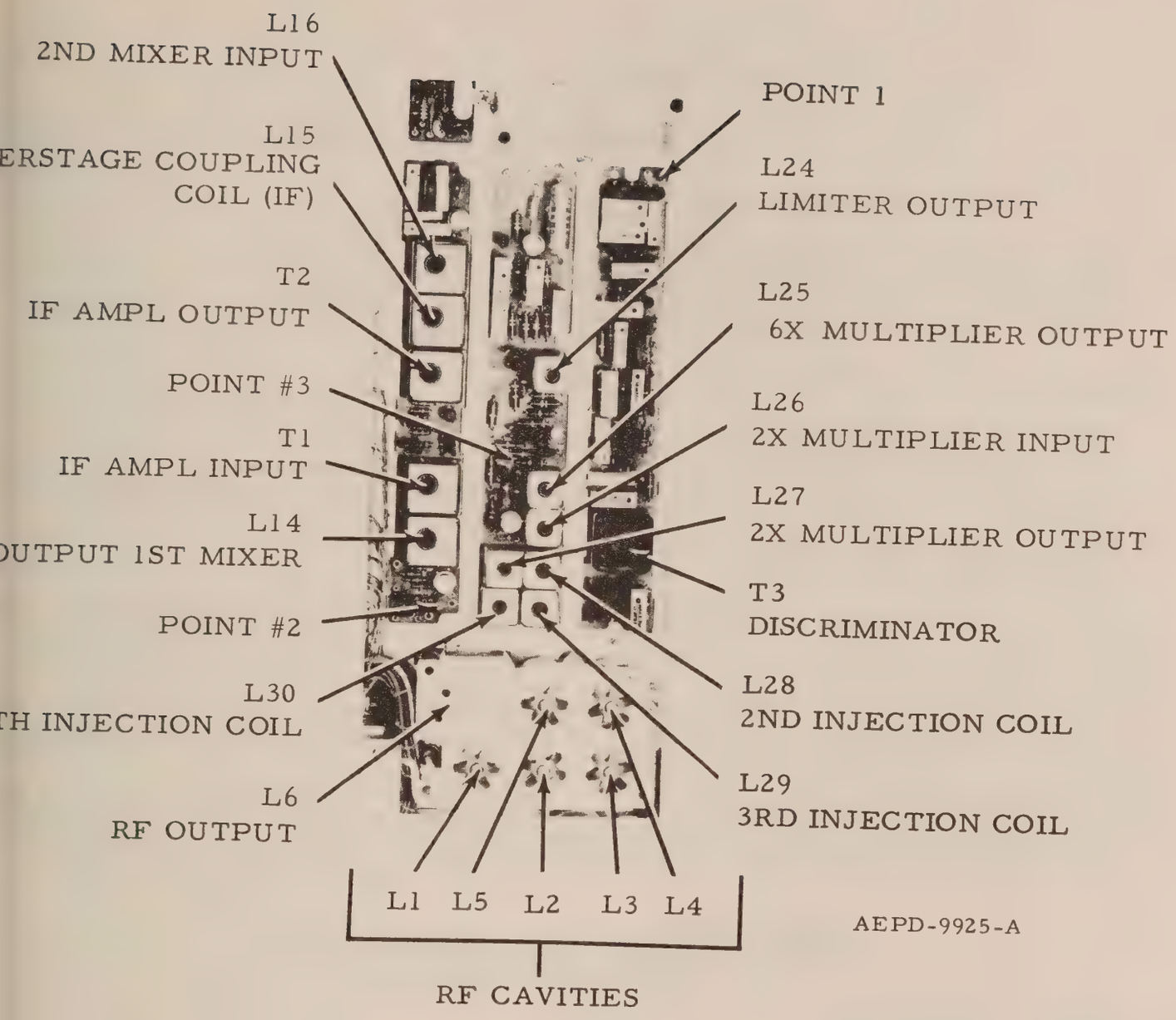
STEP	STAGE AND PROCEDURES
6 cont'd	NOTE When tuning L1 through L5 two peaks may be obtained. Use the peak which gives the maximum meter indication. In most cases the first peak will give the maximum indication. Some indication may be seen on position 2 with the tuning screws fully counterclockwise. This is due to generator radiation. Follow the tuning procedure until a definite increase in position 2 is seen due to the adjustment of the tuning screws.

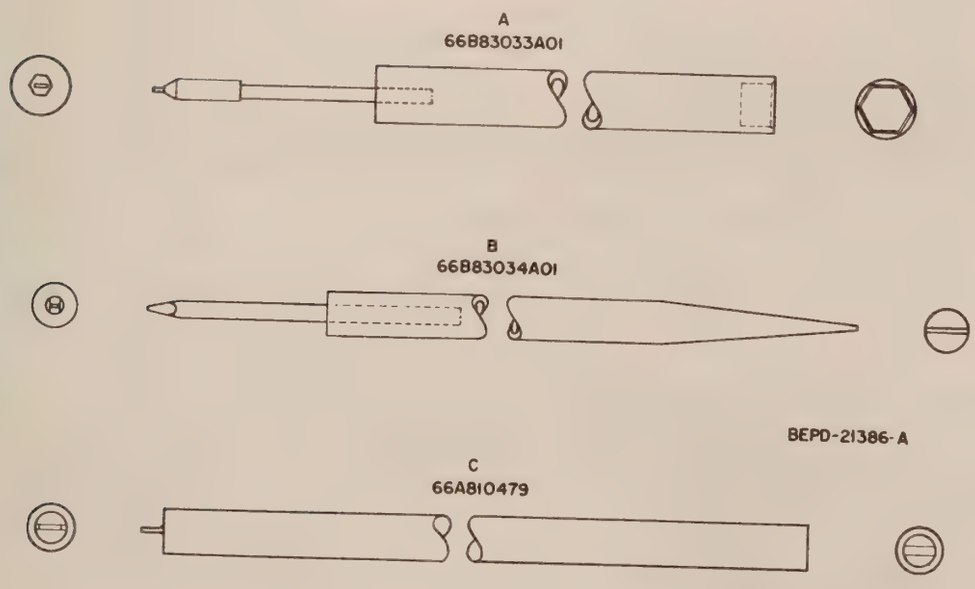
AVERAGE STAGE MEASUREMENTS WITH THE RADIO SET PROPERLY ADJUSTED

APPROXIMATE MICROVOLT INPUT	INPUT TO		FREQUENCY	RECEIVER METER POSITION	TEST SET METER READING
No signal	Antenna Disconnected			1	0
No signal	Antenna Disconnected			2	0
No signal	Antenna Disconnected			3	10
No signal	Antenna Disconnected			4	0
No signal	Antenna Disconnected			5	15
No signal	Antenna Disconnected			6	10
0.7	Antenna Connector		Carrier Freq.		20 DB Quieting
35 (Note 3)	Antenna Connector		Carrier Freq.	1	10 ua
45 (Note 3)	Base	RF Transistor (Q1)	Carrier Freq.	1	10 ua
700 (Note 3)	Collector				
250	Base	1st Mixer (Q5)	Carrier Freq.	1	10 ua
25000	Collector		5.26 mc	1	10 ua
1500	Base	5.26 mc IF Transistor (Q6)	5.26 mc	1	10 ua
6000	Collector				
1500	Base	2nd Mixer (Q8)	5.26 mc	1	10 ua
55000	Collector		0.455 mc	1	10 ua
5000	Base	455 kc Ampl. Transistor (Q9) in 455 kc filter	0.455 mc	1	10 ua
90000	Collector				
55000	Base	1st 455 kc IF Transistor (Q10)	0.455 mc	1	10 ua
1500000	Collector				

STAGE MEASUREMENT NOTES

1. All measurements made with signal generator tuned to the required frequency.
2. All measurements, except antenna input, taken with Motorola Model TEK-10 RF Cable Adapter (or equivalent).
3. Measurements taken with a jumper placed between TB203-3 and TB203-6.





ALIGNMENT PROCEDURE CONTINUED ON REVERSE SIDE OF THIS SHEET

HOW TO MEASURE 20 DB QUIETING SENSITIVITY

Test Equipment Required

1. Motorola Model T1034C Signal Generator.
2. Motorola Model S1056A-9A Portable Test Set.
3. Motorola Model TEN6055A Test Set Adapter with a Motorola AC Voltmeter or the Western Electric 3A Noise Measuring Set.

Procedure

1. Turn on the signal generator and allow it to warm up for at least one hour.
2. Connect the Motorola Model TEN6055A Test Set Adapter to the portable test set and to the rad set under test as outlined in the instructions supplied with the adapter. Place the metering se lector switch on the test set adapter to the RCVR METERING position.
3. Set the function selector switch on the portable test set to the RCVR postion. Place the positi selector switch to position 4 and the SPKR switch to the OPEN position.
4. Connect the Motorola AC Voltmeter or the Western Electric 3A Noise Measuring Set to the ap- propriate binding posts on the test set adapter. If the 3A Noise Measuring Set is used, set its function selector switch to the 600 position; use the 3 kc flat weighting; and place the NORM- DAMP switch to the DAMP position.
5. Connect the signal generator output to the ANT. receptacle on the front panel of the radio set.
6. With the signal generator frequency dial off the assigned receiver carrier frequency, note the reading on the a-c voltmeter or noise measuring set.
7. Set the signal generator on the assigned receiver carrier frequency using the "0" center on the test set meter. Adjust the output attenuator until the value of the noise voltage is reduced to 0 of its original indication (step 6). Note the setting of the signal generator output attenuator. This setting, in microvolts, represents the 20 db quieting sensitivity of the receiver.

HOW TO MEASURE 20 DB QUIETING SENSITIVITY IN DUPLEX OPERATION

Test Equipment Required

1. Motorola Model T1034B Signal Generator
2. Motorola Model S1056A-9A Portable Test Set
3. Motorola Model TEN6056A Duplex Quieting Sensitivity Measurement Adapter
4. Motorola Model TEN6055A Test Set Adapter with a Motorola AC Voltmeter or the Western Electric 3A Noise Measuring Set
5. Bird "Termaline" Model 612 Wattmeter (or equivalent).

Procedure

NOTE

Do not attempt to measure the 20 db quieting sensitivity of the receiver in duplex operation unless: the transmitter, receiver, and diplexer have been completely tuned and adjusted as per the alignment instructions in the manual; the radio set is contained and locked in the housing.

1. Turn on the signal generator and allow it to warm up for at least one hour.
2. Connect the Motorola Model TEN6055A Test Set Adapter to the portable test set and to the radio set under test as outlined in the instructions supplied with the adapter. Place the metering selector switch on the test set adapter to the RCVR METERING position.
3. Place the function selector switch on the portable test set to the RCVR position. Set the positio selector switch to position 4 and the SPKR switch to the OPEN position.
4. Connect the Motorola AC Voltmeter or the Western Electric 3A Noise Measuring Set to the ap- propriate binding posts on the test set adapter. If the 3A Noise Measuring Set is used, set its function selector switch to the 600 position; use the 3 kc flat weighting; and place the NORM- DAMP switch to the DAMP position.

DIPLEXER ALIGNMENT

The diplexer has been aligned at the factory and normally does not require readjustment. Do not align the diplexer unless certain it is essential.

A. TEST EQUIPMENT REQUIRED

1. Motorola Model S1056A-9A Portable Test Set with a Motorola Model TEN6055A Test Set Adapter (available on separate order). A 0-50 microampere meter with 20,000 ohms equivalent series resistance may be used if a test set is not available.
2. Motorola Model TLN6629B Tuning Tool Kit.
3. Bird "Termaline" Model 612 Wattmeter (or equivalent).
4. Motorola Model T1012A Power Supply (or equivalent).
5. Motorola Model T1034C Signal Generator or i-f test set has peaking generator, complete alignment can be accomplished with a YK channel element and type AUL crystals at 7269.524 kc (RCVR carrier freq) and 7094.783 kc (RCVR imag. freq).
6. Motorola Model TEN6054B Alignment Cable Kit.

B. HOW TO SET UP THE S1056A-9A PORTABLE TEST SET

1. Set the function selector switch on the portable test set to the RCVR position.
2. Place the oscillator and meter reversing switch in the OFF position.
3. Connect the 20-pin meter cable plug to the test set; connect the other end of the test set metering cable to the 11-pin female receptacle on the test set adapter (TEN6055A); place the metering selector switch on the test set adapter to the RCVR METERING position; connect the metering cables extending from the test set adapter to the metering receptacle located behind the name-plate cover on the front panel of the radio set. Note: Make certain that the cable being connected is plugged into the appropriate metering receptacle as indicated by the designations on the name-plate cover. When the test set is not being used, disconnect the 20-pin meter cable plug from the test set to conserve internal battery life. The plug on the cable acts as an on-off switch completing the battery circuit.

C. ALIGNMENT SET-UP

1. RECEIVER ALIGNMENT

a. Disconnect the shielded transmitter cable from the diplexer.
b. Set up the peaking generator or signal generator as outlined in the instruction manual supplied with the generator.
c. Connect a dummy load or wattmeter to the ANT RECP located on the front panel of the radio.
d. Connect the generator to the diplexer transmitter input using the test cable and UHF-to-Phone adapter supplied with the Model TEN6054B Alignment Cable Kit.

2. IMAGE ALIGNMENT

a. Disconnect the shielded transmitter cable from the diplexer transmitter input.
b. Set up the peaking generator or signal generator as outlined in the instruction manual supplied with the generator.
c. Connect the generator to the antenna receptacle located on the front panel of the radio set.
d. Connect the test cable (supplied with the TEN6054B Alignment Cable Kit) to the TEK-10 RF Cable Adapter using the UHF-to-Phone adapter (also supplied with the kit).
e. Connect the other end of the test cable to the diplexer transmitter receptacle. Place the probe of the r-f cable adapter (TEK-10) on the base of the first mixer (POINT 2 as illustrated in the photo contained in the receiver alignment procedure).

5. Using shielded coaxial cables only, connect the signal generator to the uhf female receptacle (GEN) on the Model TEN6056A. Duplex Quieting Sensitivity Measurement Adapter; connect the thruline wattmeter and T1013A RF Load Resistor or the terminating wattmeter to the uhf male connector (Load) on the adapter; connect the uhf female receptacle (XMTR) on the adapter to the antenna receptacle on the front panel of the radio set.

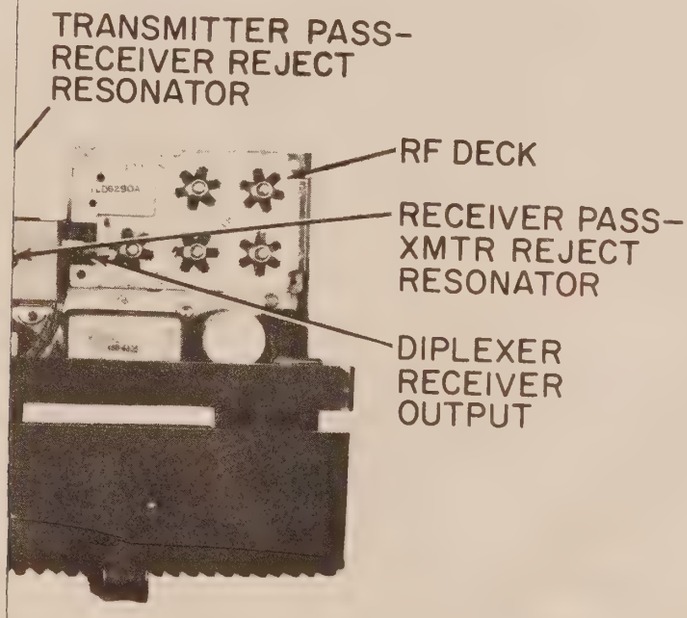
CAUTION

Make certain that the generator, transmitter, and wattmeter are connected to the sensitivity adapter as indicated by the markings on the adapter. Failure to make the proper connections to the adapter may result in serious damage to the signal generator.

6. With the signal generator frequency dial off the assigned receiver carrier frequency, note the noise reading on the a-c voltmeter or the meter on the noise measuring set.
7. Using the "0" center on the test set meter, set the signal generator on the assigned receiver carrier frequency. Adjust the output attenuator until the value of the noise voltage is reduced to 0.1 of its original indication (step 6). Note the setting of the signal generator output attenuator. This setting represents the 20 db quieting sensitivity value of the receiver with the adapter connected.
8. Key the transmitter using the XMTR switch on the test set adapter.
9. Adjust the signal generator output, if necessary, until the noise reading is again 0.1 of its original indication. Note the setting on the signal generator output attenuator. The difference in settings before and after the transmitter is keyed should not differ by more than 0.5 db.

CEDURE
E exer unless the transmitter tely tuned and adjusted. The s aligned is selected from the STEP 1 TRANSMITTER Z3, Z4 and Z5 to their maximum counterclockwise
or to receiver carrier frequency at maximum ckwise position, turn Z3 and Z4 in two turns at p. Then adjust Z3 and Z4 for a minimum on
or to maximum output at the image frequency. meter position #2 begins to drop. Then adjust position #2. he set level of the peaking generator to e receiver.

epeak L110 (ANT. COUPLING) and C152 (ANT.
ALIGNMENT PROCEDURE.



T. AEPD-9922-O

0479

AEPD-9921-O

5. Using shielded coaxial cables only, connect the signal generator to the uhf female receptacle (GEN) on the Model TEN6056A. Duplex Quieting Sensitivity Measurement Adapter; connect the thruline wattmeter and T1013A RF Load Resistor or the terminating wattmeter to the uhf male connector (Load) on the adapter; connect the uhf female receptacle (XMTR) on the adapter to the antenna receptacle on the front panel of the radio set.

CAUTION

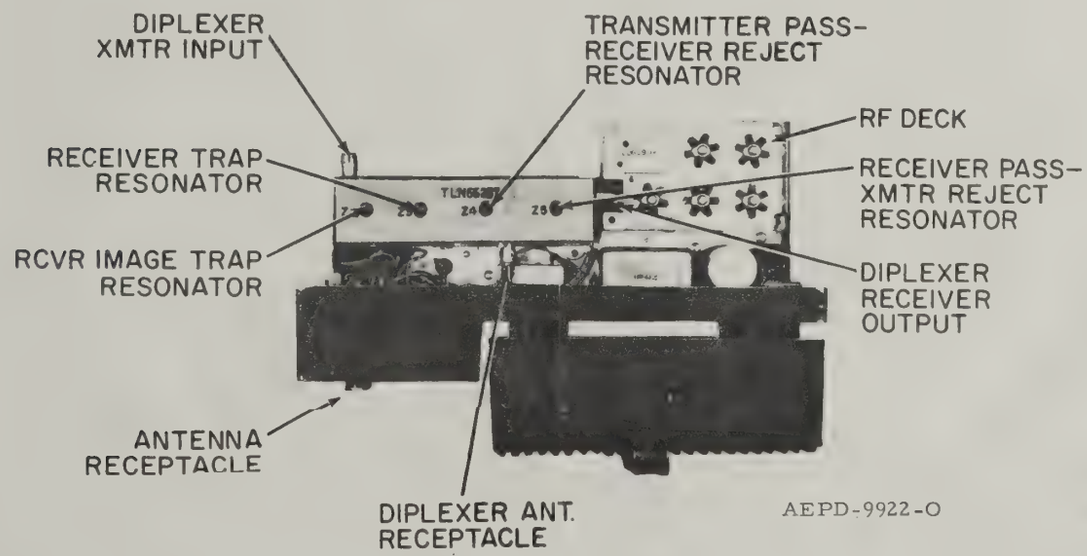
Make certain that the generator, transmitter, and wattmeter are connected to the sensitivity adapter as indicated by the markings on the adapter. Failure to make the proper connections to the adapter may result in serious damage to the signal generator.

6. With the signal generator frequency dial off the assigned receiver carrier frequency, note the noise reading on the a-c voltmeter or the meter on the noise measuring set.
7. Using the "0" center on the test set meter, set the signal generator on the assigned receiver carrier frequency. Adjust the output attenuator until the value of the noise voltage is reduced to 0.1 of its original indication (step 6). Note the setting of the signal generator output attenuator. This setting represents the 20 db quieting sensitivity value of the receiver with the adapter connected.
8. Key the transmitter using the XMTR switch on the test set adapter.
9. Adjust the signal generator output, if necessary, until the noise reading is again 0.1 of its original indication. Note the setting on the signal generator output attenuator. The difference in settings before and after the transmitter is keyed should not differ by more than 0.5 db.

D. ALIGNMENT PROCEDURE

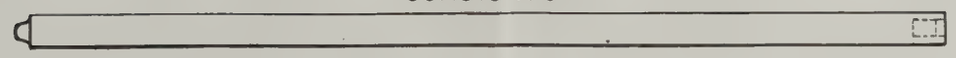
STEP	STAGE AND PROCEDURE
1	NOTE Do not attempt to align the diplexer unless the transmitter and receiver have been completely tuned and adjusted. The channel on which the diplexer is aligned is selected from the order of preference outlined in STEP 1 TRANSMITTER ALIGNMENT PROCEDURE. Use tuning tool C. Turn the slugs in Z2, Z3, Z4 and Z5 to their maximum counterclockwise position.
2	Set the signal generator or peaking generator to receiver carrier frequency at maximum output. Starting at the maximum counterclockwise position, turn Z3 and Z4 in two turns at a time until meter position #1 begins to drop. Then adjust Z3 and Z4 for a minimum on meter position #2.
3	Set the signal generator or peaking generator to maximum output at the image frequency. Turn Z2 and Z5 in two turns at a time until meter position #2 begins to drop. Then adjust Z2 and Z5 for a minimum reading on meter position #2. NOTE: It may be necessary to reduce the set level of the peaking generator to reduce possible radiation into the receiver.

After the diplexer has been completely aligned, repeak L110 (ANT. COUPLING) and C152 (ANT. TRIMMER). Refer to STEP 10 in the TRANSMITTER ALIGNMENT PROCEDURE.



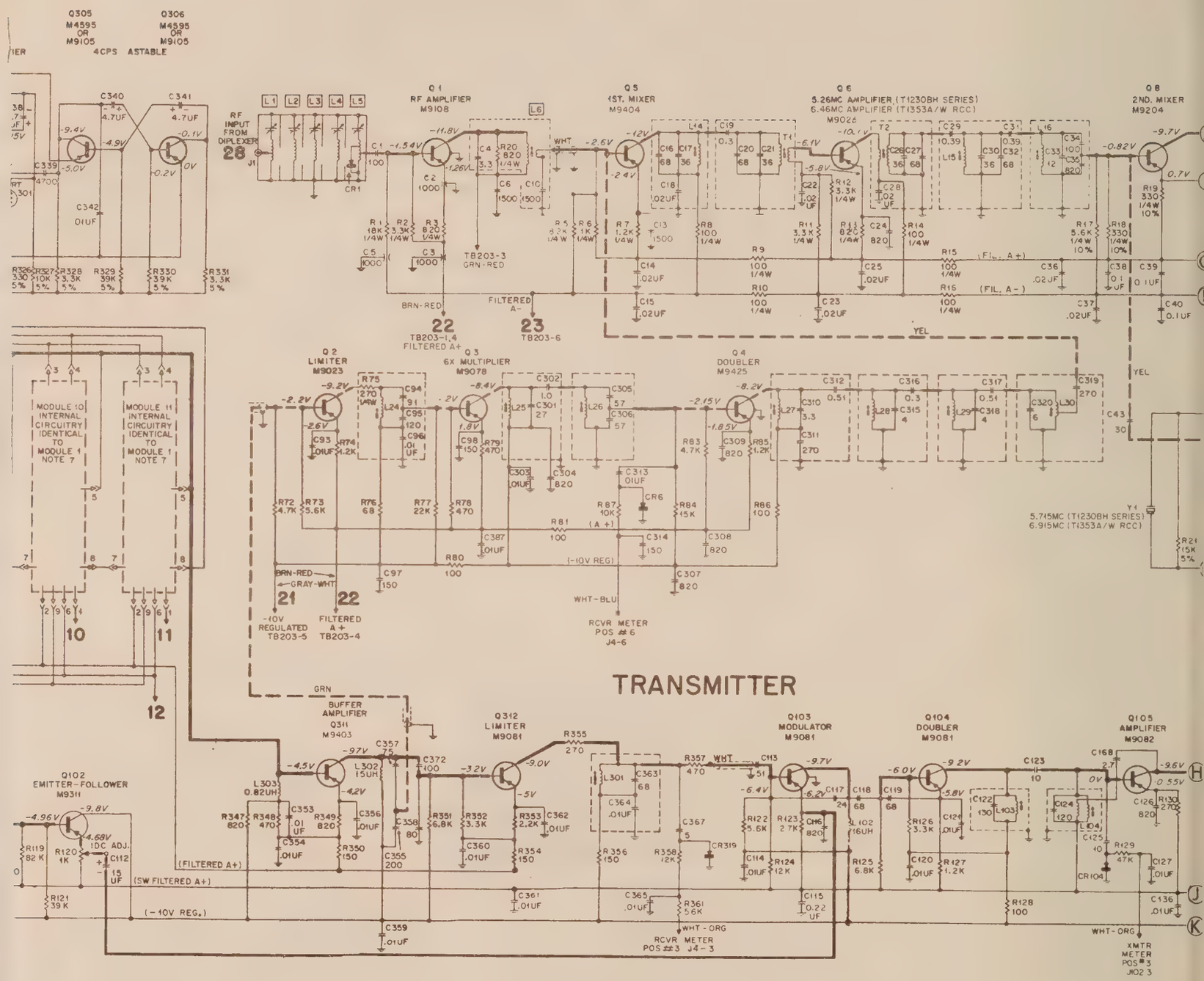
(C)

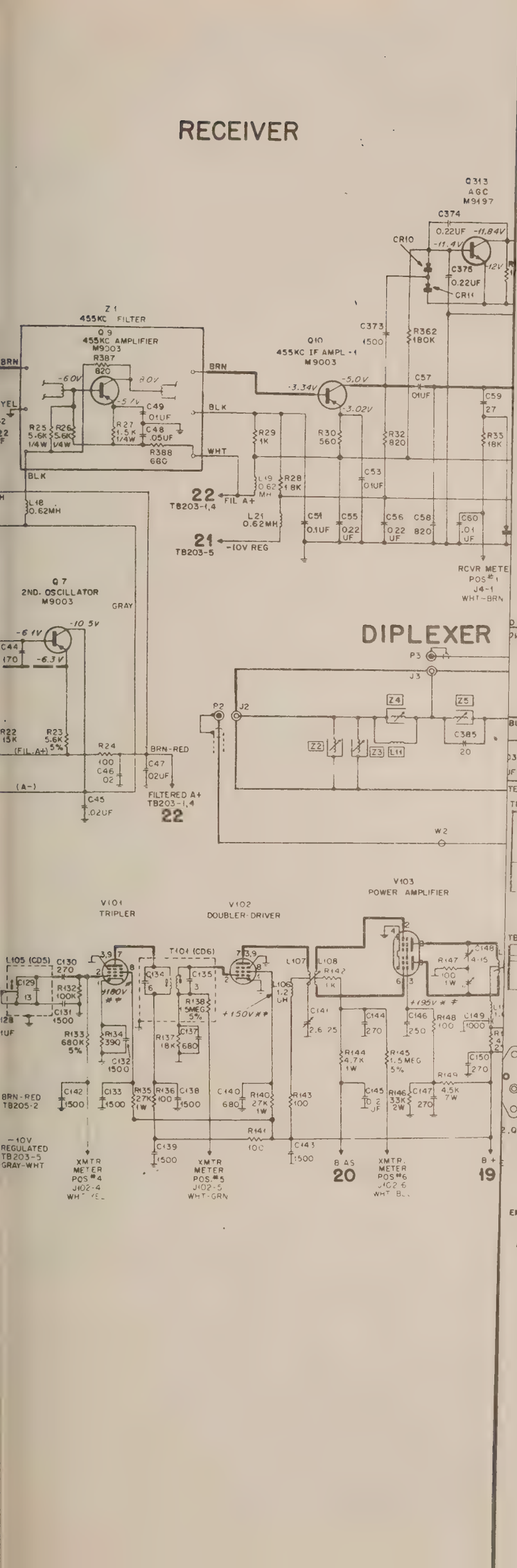
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AEPD-9921-O

Diplexer Alignment Procedure
152-162 MC, 20 W, ±12 V DC
Motorola Car Telephone Diplexer
Motorola No. EPD-9920-C (T-2831B)
2/18/68-


Q305 M4595 OR M9105
Q306 M4595 OR M9105
4CPS ASTABLE
Q1 RF AMPLIFIER M9108
Q5 1ST. MIXER M9404
Q6 5.26MC AMPLIFIER (T1230BH SERIES) 6.46MC AMPLIFIER (T1353A/W RCC) M9026
Q8 2ND. MIXER M9204
RF INPUT FROM DIPLEXER
28
TB203-3 GRN-RED
BRN-RED
22
TB203-1,4 FILTERED A+
FILTERED A-
23
TB203-6
(FIL. A+)
(FIL. A-)
YEL
Q2 LIMITER M9023
Q3 6X MULTIPLIER M9078
Q4 DOUBLER M9425
MODULE 10 INTERNAL CIRCUITRY IDENTICAL TO MODULE 1 NOTE 7
MODULE 11 INTERNAL CIRCUITRY IDENTICAL TO MODULE 1 NOTE 7
Y1
5.715MC (T1230BH SERIES)
6.915MC (T1353A/W RCC)
BRN-RED
GRAY-WHT
21
-10V REGULATED TB203-5
22
FILTERED A+ TB203-4
(-10V REG)
WHT-BLU
RCVR METER POS #6 J4-6
10
11
12
TRANSMITTER
GRN
BUFFER AMPLIFIER Q311 M9403
Q312 LIMITER M9081
Q103 MODULATOR M9081
Q104 DOUBLER M9081
Q105 AMPLIFIER M9082
Q102 EMITTER-FOLLOWER M9311
.1DC ADJ.
(FILTERED A+)
(SW FILTERED A+)
(-10V REG.)
WHT-ORG
RCVR METER POS #3 J4-3
XMTR METER POS #3 J102-3



NOTES

1. FREQUENCY CALCULATIONS:

$$\text{RECEIVER} — f_o = \frac{f_c + 5.26\ \text{MC}}{12}$$

$$\text{TRANSMITTER} — f_o = \frac{f_c}{12}$$

2. CRYSTAL FREQUENCY RANGE IS FROM 13.147500 MC TO 13.172500 MC.
3. UNLESS OTHERWISE STATED:
   RESISTOR VALUES ARE IN OHMS, ±10%, 1/2 W, K = 1000
   CAPACITOR VALUES ARE IN MICROMICROFARADS.
4. SEE PARTS LISTS FOR COMPONENT VALUES.
5. ALL VOLTAGE MEASUREMENTS MADE USING A MOTOROLA DC MULTIMETER. ALL VOLTAGES TAKEN WITH REFERENCE TO FILTERED A+ (RED-BRN WIRE) WITHOUT AN INCOMING SIGNAL, TRANSMITTER NOT KEYED, CHANNEL 1 SELECTED, AND 13.7 VOLTS AT THE BATTERY TERMINALS UNLESS OTHERWISE INDICATED. READINGS MAY VARY ±20%.
   * VOLTAGE TAKEN WITH TRANSMITTER KEYED AND 13.7 VOLTS AT BATTERY TERMINAL
   ± VOLTAGE TAKEN WITH REFERENCE TO CHASSIS GROUND.
6. HEAVY DASHED LINES DENOTE RECEIVER INJECTION SIGNAL.
7. DUMMY ELEMENT MUST BE USED IN PLACE OF CHANNEL ELEMENT WHEN OPERATION ON THAT CHANNEL IS NOT DESIRED.
8. A JUMPER BETWEEN PINS 23 AND 24 ARE PRESENT ON TLD1100A RADIO UNITS ONLY.
   A JUMBER BETWEEN PINS 20 AND 23 ARE PRESENT ON TLD1220A RADIO UNITS ONLY.

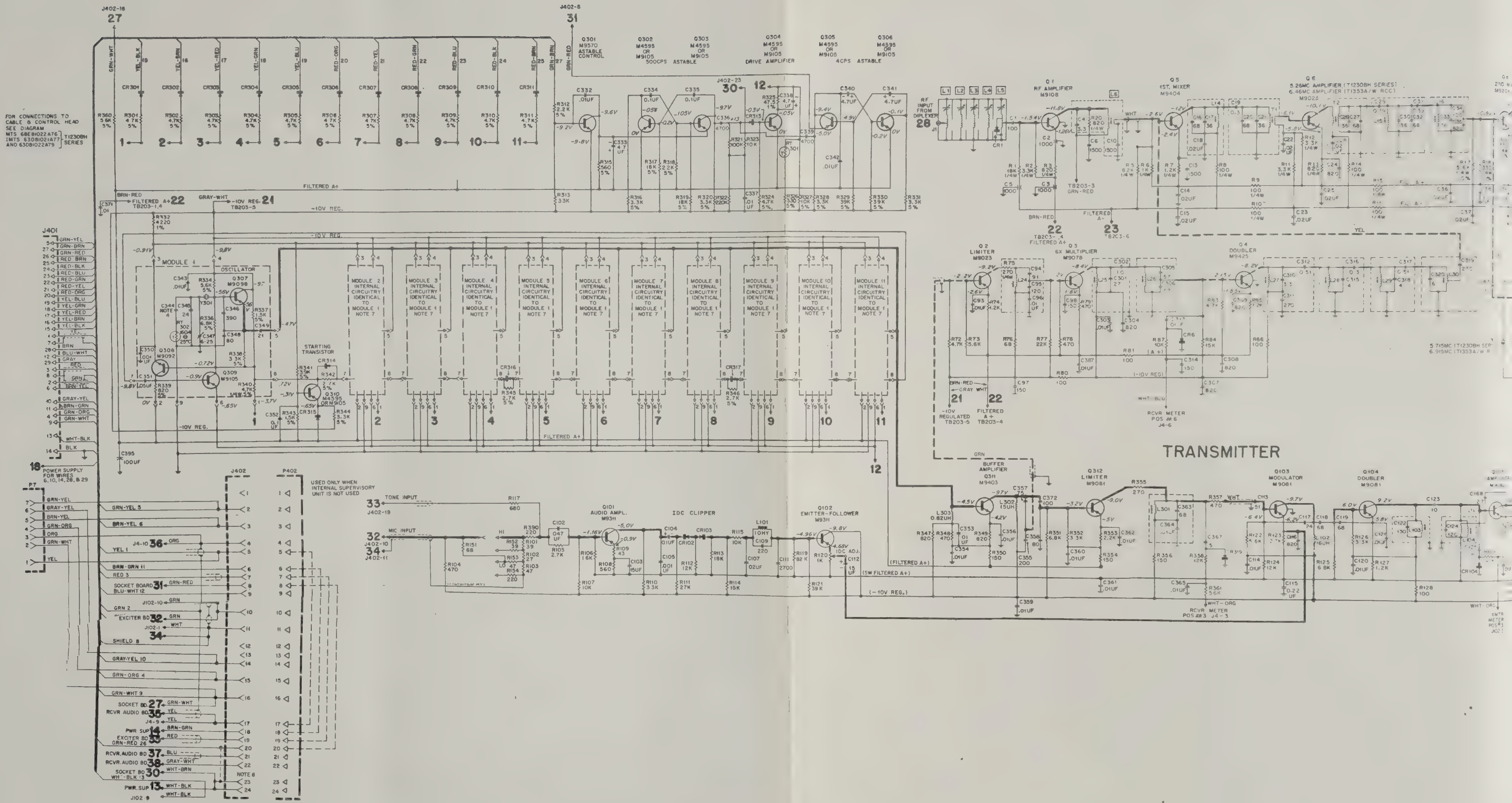
MODEL TABLE

MODEL	SUFFIX	DESCRIPTION
TUD1160AB	7	UNIFIED CHASSIS

EPS-2550-A

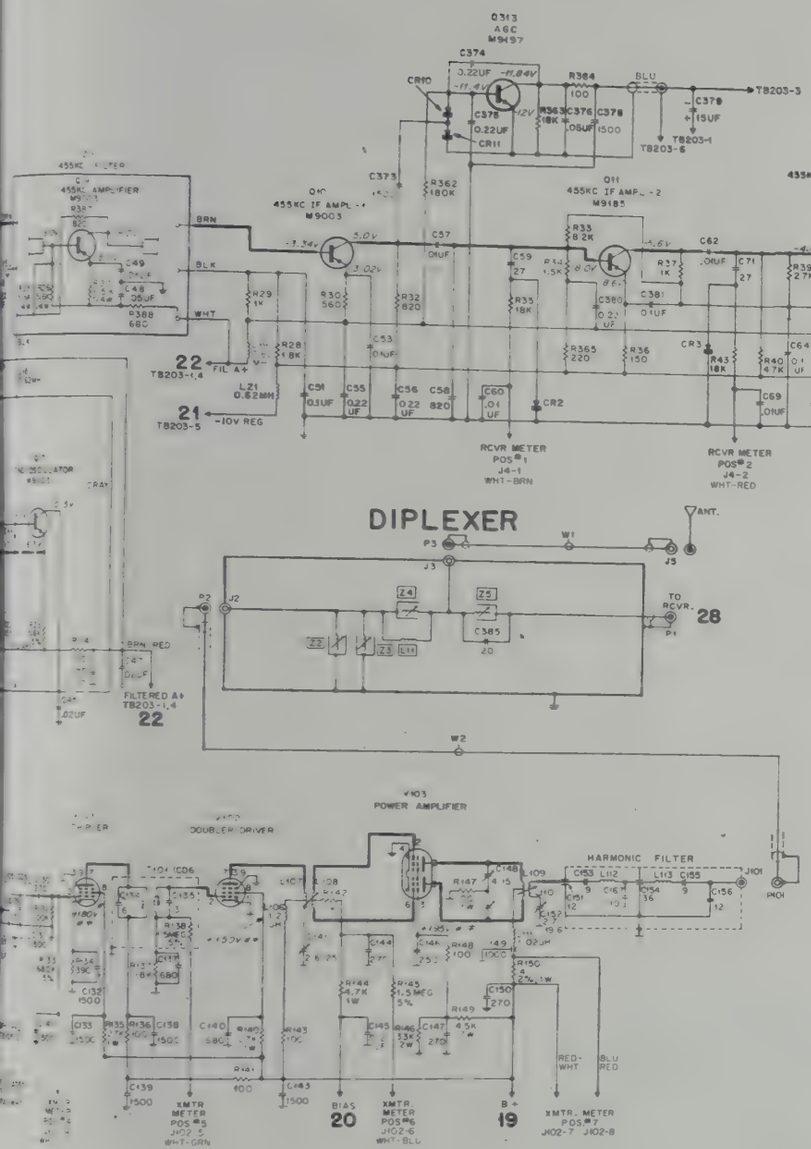
PREVIOUS REVISIONS AND PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

152-162 MC, 20 W, ±12 V DC
Motorola Car Telephone Radio Set
Schematic and Intercabling Diagram
Motorola No. 63E81022A67-AC (SMR-1173E)
1/14/72-



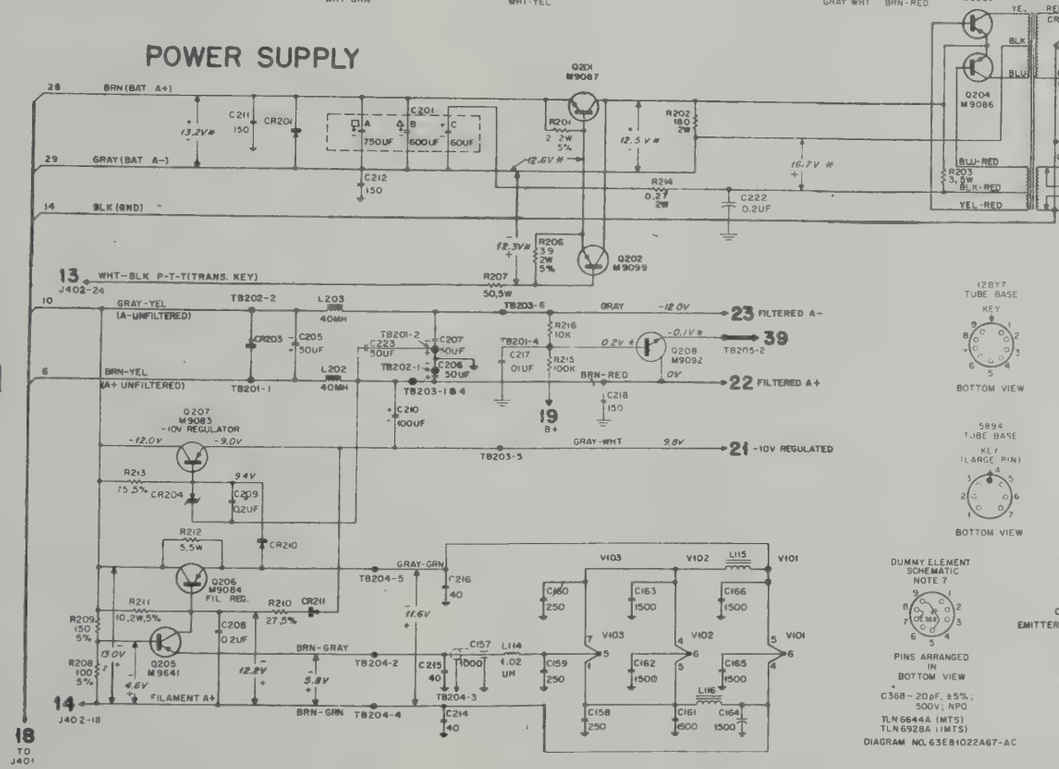
TRANSMITTER
FOR CONNECTIONS TO CABLE & CONTROL HEAD SEE DIAGRAM MTS 68E81022A76 IMTS 63D81021A77 AND 63D81022A79 T1230BH SERIES
J402-16
27
J402-8
31
Q301 M9570 ASTABLE CONTROL
Q302 M4595 OR M9105
Q303 M4595 OR M9105
500CPS ASTABLE
Q304 M4595 OR M9105 DRIVE AMPLIFIER
Q305 M4595 OR M9105
Q306 M4595 OR M9105
4CPS ASTABLE
J402-23
RF INPUT FROM DIPLEXER
Q1 RF AMPLIFIER M9108
Q5 1ST. MIXER M9404
Q6 5.26MC AMPLIFIER (T1230BH SERIES) 6.46MC AMPLIFIER (T1353A/W RCC) M9028
FILTERED A+
-10V REG.
FILTERED A+ TB203-1,4
-10V REG. TB203-5
TB203-3 GRN-RED
FILTERED A- TB203-6
J401
MODULE 1
OSCILLATOR
Q307 M9098
Q308 M9092
Q309 M9105
STARTING TRANSISTOR
Q310 M4595 OR M9105
MODULE 2 INTERNAL CIRCUITRY IDENTICAL TO MODULE 1 NOTE 7
Q2 LIMITER M9023
Q3 6X MULTIPLIER M9078
Q4 DOUBLER M9425
5.715MC (T1230BH SERIES) 6.915MC (T1353A/W R...
-10V REGULATED TB203-5
FILTERED A+ TB203-4
RCVR METER POS #6 J4-6
POWER SUPPLY FOR WIRES 6, 10, 14, 28, & 29
J402
P402
USED ONLY WHEN INTERNAL SUPERVISORY UNIT IS NOT USED
TONE INPUT
J402-19
MIC INPUT
J402-10
J402-11
Q101 AUDIO AMPL. M9311
IDC CLIPPER
Q102 EMITTER-FOLLOWER M9311
IDC ADJ.
BUFFER AMPLIFIER Q311 M9403
Q312 LIMITER M9081
Q103 MODULATOR M9081
Q104 DOUBLER M9081
RCVR METER POS #3 J4-3
XMTR METER POS #3
SOCKET BOARD
EXCITER BD
RCVR AUDIO BD
PWR SUP
SOCKET BD
NOTE 8

RECEIVER



DIPLEXER

POWER SUPPLY



NOTES

1. FREQUENCY CALCULATIONS:

$$\text{RECEIVER} — f_o = \frac{f_c + 5.26\ \text{MC}}{12}$$

$$\text{TRANSMITTER} — f_o = \frac{f_c}{12}$$

2. CRYSTAL FREQUENCY RANGE IS FROM 13.147500 MC TO 13.172500 MC.
3. UNLESS OTHERWISE STATED:
   RESISTOR VALUES ARE IN OHMS, ±10%, 1/2 W, K = 1000
   CAPACITOR VALUES ARE IN MICROMICROFARADS.
4. SEE PARTS LISTS FOR COMPONENT VALUES.
5. ALL VOLTAGE MEASUREMENTS MADE USING A MOTOROLA DC MULTIMETER. ALL VOLTAGES TAKEN WITH REFERENCE TO FILTERED A+ (RED-BRN WIRE) WITHOUT AN INCOMING SIGNAL, TRANSMITTER NOT KEYED, CHANNEL 1 SELECTED, AND 13.7 VOLTS AT THE BATTERY TERMINALS UNLESS OTHERWISE INDICATED. READINGS MAY VARY ±20%.
   · VOLTAGE TAKEN WITH TRANSMITTER KEYED AND 13.7 VOLTS AT BATTERY TERMINAL
   # VOLTAGE TAKEN WITH REFERENCE TO CHASSIS GROUND.
6. HEAVY DASHED LINES DENOTE RECEIVER INJECTION SIGNAL.
7. DUMMY ELEMENT MUST BE USED IN PLACE OF CHANNEL ELEMENT WHEN OPERATION ON THAT CHANNEL IS NOT DESIRED.
8. A JUMBER BETWEEN PINS 23 AND 24 ARE PRESENT ON TLD1100A RADIO UNITS ONLY.
   A JUMBER BETWEEN PINS 20 AND 23 ARE PRESENT ON TLD1220A RADIO UNITS ONLY.

MODEL TABLE

MODEL	SUFFIX	DESCRIPTION
TUD1160AB	*	UNIFIED CHASSIS

EPS-2550-A

PREVIOUS REVISIONS AND PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

152-162 MC, 20 W, ±12 V DC
Motorola Car Telephone Radio Set
Schematic and Intercabling Diagram
Motorola No. 63E81022A67-AC (SMR-1173E)
1/14/72-

REVISIONS 63E81022A67- AC(2 of 2)

CHANGE	LOCATION	REFER TO CIRCUIT BOARD
DDED .01 uf	J102-4, 11	NONE
		5.26 MC IF BD. EPD-10088-H
		AUDIO-1ST OSC. MULT. BD. EPD-9975-F
		EXCITER BD. EPD-9978-G
		2ND OSC. BD. EPD-8828-J
		AUDIO-1ST OSC. MULT. BD. EPD-9975-G
ERE 23C82645A03, 5 uf +100-10%; 25 v	Q208 COL-LECTOR	NONE
		POWER SUPPLY AND REGULATOR BOARD EPD-8782-K
DDED RF CHOKE	V102-4	NONE
	V102-6	
DDED 1500 UUF	-10 V (TB207-3)	
DDED RF CHOKE		
DDED TERMINAL OARD	T201	
DDED 100 UF	FILTERED A+	
		5.26 MC IF BOARD EPD-10088-K
DDED 0.2 UF	T201	NONE
DDED 50 UF	L202	
		CHAN. ELEM. SCKT. BD. EPD-9972-J

T

RECEIVER

k (152-162 mc) EPD-10186-O

OTOROLA ART NO.	DESCRIPTION
	CAPACITOR, fixed: uuf; 500 v; unl. stated
K840046	100 ±10%
B861219	1000 GMV
K868382	3.3 ±5%; N150
C82187B11	1500 ±10%; 100 v
	SEMICONDUCTOR DEVICE, diode: NOTE 1
C82617C01	silicon
C82617C03	silicon
	CONNECTOR, receptacle;
87120	female; single contact
	COIL, RF:
382890D10	coded CD2
382890D03	coded CB5
382890D11	coded CD3; incl. ref. part CR1
780902A97	coded CD4; incl. ref. parts C4, C6, C10 and 76B82451B03 CORE, iron
	TRANSISTOR: NOTE 1
8869108	P-N-P; type M9108
	RESISTOR, fixed: ±10%; 1/4 w; unl. stated
128904	18K
129231	3.3K
129432	820
ON-REFERENCED ITEMS	
30728A45	HOUSING ASSY.: incl. ref part J1
30721A84	TOP PLATE & TUNING COLLAR ASSY.
832397	LUG, terminal: 2 used
82533E01	COVER

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION

TRANSMITTER

TLN6625A Power Amplifier EPD-8817-F

		CAPACITOR, fixed: uuf; unl. stated
C129	21K865054	13 ±5%; 500 v; N330
C130, 144, 147, 150	21C82187B04	270 ±10%; 500 v; X5F
C131, 132, 133, 138, 139, 142, 143, 161, 162, 163, 164, 165, 166	21B800801	1500 GMV; 100% max.; 500 v; Z5U
C134	21D82355B19	6 ±5%; 500 v; N470
C135	21K832520	3 ±0.25; 500 v; N470
C137, 140	21K865452	680 ±10%; 500 v; X5F
C141	19C82105G01	var.; 2.6-25 uuf; 850 v
C145	21C82372C02	0.2 uf +80-20%; 25 v
C146, 158, 159, 160	21K863801	250 ±10%; 350 v
C148	1V80728A78	assy.; var.; 4.2-15 uuf; 1600 v; incl. STRAP, plate
C149, 157	21K861219	1000 uuf; GMV; 500 v; coded RED
C151	21K859875	12 ±5%; 500 v
C152	19C82629E02	var.; 2.7-19.6 uuf; 750 v
C153, 155	21D82610C33	9 ±5%; 4KV; NP0
C154	21B82096G01	36 ±5%; 500 v; N80
C156	21K847874	12 ±5%; 500 v; NP0
C167	21K410063	10 ±5%; 500 v; NP0
		CONNECTOR, receptacle:
J101	9A87120	female; single contact
		COIL, RF:
L105	24B82118G01	CD5; incl. ref. part C129 and 1V80728A83 CORE ASSY., tuning
L106	24C82000E09	choke; 1.2 uh; sleeved
L107	24B82109G01	driver plate
L108	1V80731A25	PA grid; incl. shield & bracket
L109	24B82110G01	PA plate
L110	1V80728A81	antenna coupling
L111, 114	24V80900A86	choke; 1.02 uh; sleeved
L112, 113	24B82111G01	input & output; harmonic filter
L115, 116	1V80718B43	2 turns; sleeved
		RESISTOR, fixed: ±10%; 1/2 w; unl. stated
R132	6R6031	100K
R133	6R5775	680K ±5%
R134	6R5554	390
R135, 140	6R6427	27K; 1 w
R136, 141, 143, 148	6R6326	100
R137	6R5591	18K
R138	6R400228	1.5 meg ±5%
R142	6R6229	1K
R144	6R5576	4.7K; 1 w
R145	6R400228	1.5 meg ±5%
R146	6R5768	33K; 2 w
R147	6R6415	100; 1 w
R149	17C82177B15	4.5K; 7 w
R150	17K892469	4 ±2%; 1 w
		TRANSFORMER:
T101	24C82113G01	CD6; incl. ref. parts C134, C135, R138 and (2) 1V80728A83 CORE ASSY., tuning
		ELECTRON TUBE:
V101, 102	65A83735A02	special purpose: tripler doubler driver
V103	65A83735A01	special purpose: power amplifier
		SOCKET, electron tube:
XV101, 102	9[illegible]11[illegible]01	ceramic; 9 contact
XV103	9B82[illegible]4A01	steatite; 7 contact
ON-REFERENCED ITEMS		
	26A[illegible]2305A[illegible]	SHIELD, heat dissipator
	6 [illegible] [illegible]A01	SHIELD, tube
	A8230-B 1	SPRING, tube shield

TLN6619B Chassis Component Kit — EPD-10194-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uf; unl stated
C86	21K801139	.01 uf +80-20%; 600 v
C201	23D82178B04	3 section; c/o:
C201A		□ 750 +100-0%; 25 v
C201B		△ 600 +100-0%; 25 v
C201C		60 +100-0%; 25 v
C204	8D82122B04	2 section; c/o:
C204A		1.0 ±20%; 600 v
C204B		1.0 ±20%; 600 v
C204C		common
C205, 206, 207, 223	23D83550B02	50 +150-10%; 25 v; non-pol.
C210	23D82601A09	100 +150-10%; 25 v
C211, 212, 218	21K863147	150 uuf ±10%; 500 v
C214 thru 216	21K849338	40 uuf ±5%; 500 v; NP0
C217, 388, 389, 390	21D82428B06	.01 +70-30%; 100 v
C221	21B800801	1500uuf GMV; 100% max; 500 v
C222	21C82352C05	0.2; 25 v
C379	23K865136	15 ±20%; 25 v
C395	23D83210A08	100+150-10%; 25 v
		SEMICONDUCTOR DEVICE, diode: NOTE I
CR201, 203	48C82525G01	silicon
		CONNECTOR, receptacle:
J4, 102	9C880881	female; 11 contact
J401	28C82546E01	male; 29 contact
J5	9K85615	female; single contact does not incl 15A483599 HOOD
J402	9B84620C01	female; 24 contact
		COIL, RF choke:
L32	25B82878A04	70 mh
L202, 203	25C82227G01	40 mh
L204	25C82063G01	100 mh
L206	1V80718B43	2 turns
		CONNECTOR, plug:
P3	28A474006	male; single contact
		TRANSISTOR: SEE NOTE
Q208	48R869092	N-P-N; type M9092
		RESISTOR, fixed; ±10%; unl stated
R214	17C82036G05	0.27; 2 w
R216	6R6320	10K; 1/2 w
R217	6R2099	100K; 2 w
		BOARD, terminal
TB201	31R120965	3 ins. #3 gnd.
TB202	31R120174	1 ins. #2 gnd.
TB203	31R127617	5 ins. #2 gnd.
TB204	31R124448	4 ins. #3 gnd.
TB205	31R120364	1 ins. #1 gnd.
TB207	31S124445	3 ins. #1 mtg
		CABLE, RF:
W1	1V80729A63	assy.; incl. ref. parts J5, P3 and 30K475378 CABLE, RF: coaxial; RG/58AU; 8" req'd

TLN6644A Channel By-Pass Element
TLN6928A Channel By-Pass Element — EPD-8823-E

		CAPACITOR, fixed:
C368	21K840849	20 uuf ±5%; 500 v; NP0
NON-REFERENCED ITEMS		
	28C82992E02	CONNECTOR, male: 9 contact
	1V80771A18	COVER, connector (TLN6644A only)
	15A84912B01	BUTTON, push: blank (TLN6644A only)
	15A84911B01	COVER, connector (TLN6928A only)

TLN6627B Unit Component Kit — EPD-10196-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uuf
C97, 314	21K863147	150 ±10%; 500 v
C391	21K868996	1500; 100 v
		CONNECTOR, plug:
P2, 101	28A474006	male; single contact
		CABLE, RF transmission:
W2	1V80730A71	incl. ref. parts P2, P101 and 30A836551 CABLE, coaxial: RG-122/U 19" req'd 10M9401 BRAID, shield: 12" req'd

THN6042A Housing Kit — EPD-8825-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	15E82050E01	HOUSING, top
	15E82050E03	HOUSING, bottom

TLN6628B Diplexer Kit — EPD-10193-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed:
C385	21K840849	20 uuf ±5%; 500 v; NP0
		CONNECTOR, receptacle:
J2, 3	9C87120	female; single cont.
		COIL, RF:
L11	24A82666H01	winding
		CONNECTOR, plug:
P1	28A474006	male; single cont.
		COIL, assy:
Z2, 4	24C82705H01	resonator
Z3, 5	24C82705H02	resonator
NON-REFERENCED ITEMS		
	15B82750H01	COVER, diplexer: screened
	15D82738H01	HOUSING, diplexer
	3A8[illegible]227A01	SCREW, special: 3 used

TLN6902A Unit Hardware Kit
TLN6903A Unit Hardware Kit — EPD-10670-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CONNECTOR, plug:
P402	28B851574	male; 24 contact
NON-REFERENCED ITEMS		
	55B83032A01	HANDLE, connector (P402)
	1V80739A74	PLATE ASSY., channel element hold-down
	41B828[illegible]6H01	SPRING, decoder bracket (used on TLN6903A only)

NOTES:

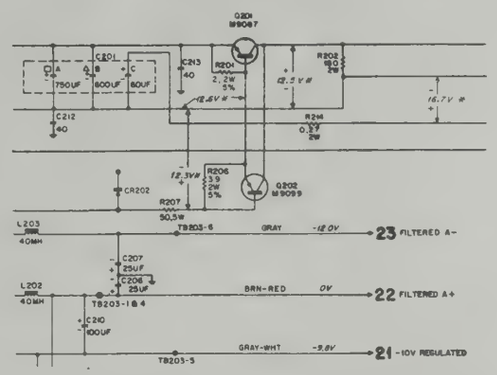
I. Replacement transistors and diodes must be ordered by Motorola part number only for optimum performance.

II. Crystals are part of the radio set model only. If replacement is necessary, crystals must be ordered separately. When ordering xtal units specify car. freq. (s), xtal freq. (s) and xtal type no.

REVISIONS

63E81022A67-AC (1 of 2)

CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION	REFER TO CIRCUIT BOARD
TUD1160AB-1	C388 C389	ADDED .01 uf ADDED .01 uf	I4-5 J4-4	NONE
TLN6623B-1				455 KC IF BD EPD-9981-A
TUD1160AB-1		ADDED 68P81022A65	DIAGRAM BOOKLET LIST	
TUD1160AB-1		TLN6902A AND TLN6903A ADDED	PARTS LIST	
TUD1160AB-2	C211, C212	WERE. 21K849338, 40 uuf	Q201 EMITTER	NONE
	C213	REMOVED. 21K849338 40 uuf		
	C217	ADDED .01 uf		
	C218	ADDED 150 uuf	Q203	
	R216	ADDED 10E		
	R217	ADDED 100K		
	Q203	ADDED. M8092 CIRCUIT WAS AS SHOWN BELOW		



	C[illegible]514	ADDED. 150 uuf	PARTS LIST	NONE
TPN6046A-2	CR202	REMOVED	LEFT OF Q202	EPD-8782-H
TLN6619B-3		REVISED CIRCUIT WIRING; ADDED NOTE #8		NONE
TLN6620B				EPD-9972-B
TUD1160AB-2	V101, 102	WERE 95R164A02 TYPE 12BY7A	TRIPLER DOUBLER	NONE
	V103	WAS 95R111A01 TYPE 5894	PWR. AMPLIFIER	
TLN6610A-1				CHAN. ELEM. BD. EPD-8737-F
TLN6623B				455 KC BD. EPD-9981-C
TLN6623B-2				455 KC BD. EPD-9981-E
TUD1160AB-3	C149, 157	WERE 21K856835 1000 uuf	PARTS LIST	NONE
TLN6623B-3				455 KC BD. EPD-9981-F
TLN6620B-1				OSC. CKT BD. EPD-9972-C
TLN6622B-2				AUDIO & SQ. BD. EPD 9975-C
TLN6621B-2				5.26 MC BD. EPD 10088-E
TUD1160AB-4	C391	ADDED 1500 uuf	L23	NON
TLN6624A-1				2ND OSC. BD. EPD-8828-F
TLN6621A-3				5.2[illegible] MC IF BD. EPD-[illegible]088-F
TLN6622B-3				AUDIO & SQ. BD EPD-9975-D
TLN6623B-4				455 KC BD. EPD 9981-G
TLD6300B-2				AUDIO EXCITER BD. EPD-[illegible]78-D
TLN6620B-2				OSC. MOD. BD EPD-9972-D
TLN6622B-3				MULTIPLIER BOARD EPD-9975-[illegible]
TLD6300B-3				AUDIO-EXCITER BOARD EPD-[illegible]78-[illegible]
TLN6610A-2				CHANNEL ELEMENT BOARD EPD-8737-G

REVISIONS

63E81022A67-AC (2 of 2)

CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION	REFER TO CIRCUIT BOARD
TUD1160AB-5	C86	ADDED .01 uf	J102-4, 11	NONE
TUD1160AB-6				5.26 MC IF BD. EPD-10088-H
				AUDIO-1ST OSC. MULT. BD. EPD-9975-F
TLD6300B-4				EXCITER BD. EPD-9978-G
TLN6624A-2				2ND OSC. BD. EPD-8828-J
TLN6622B-5				AUDIO-1ST OSC. MULT. BD. EPD-9975-G
TUD1160AB-6	C205, 206, 207	WERE 23C82645A03, 25 uf +100-10%, 25 v	Q208 COLLECTOR	NONE
TPN6046A-3				POWER SUPPLY AND REGULATOR BOARD EPD-8782-K
TLN6625A-2	L115	ADDED RF CHOKE	V102-4	NONE
	L116		V102-5	
TUD1160AB-7 (TLN6619B-5)	C221	ADDED 1500 UUF	-10 V (TB207-5)	
	L206	ADDED RF CHOKE		
	TB207	ADDED TERMINAL BOARD	T201	
	C395	ADDED 100 UF	FILTERED A-	
TLN6621B-5				5.26 MC IF BOARD EPD-10088-K
TLN6619B-6	C222	ADDED 0.2 UF	T201	NONE
	C223	ADDED 50 UF	L206	
TLN6620B-3				CHAN. ELEM SCKT. BD. EPD-9972-J

PARTS LIST

RECEIVER

TLD6290B RF Deck (152-162 mc) EPD-10186-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uuf; 500 v; unl. stated
C1	21K840046	100 ±10%
C2, 3, 5	21B861219	1000 GMV
C4	21K868382	3.3 ±5%; N150
C6, 10	21C82187B11	1500 ±10%; 100 v
		SEMICONDUCTOR DEVICE, diode: NOTE 1
CR1	48C82617C01	silicon
	or48C82617C03	silicon
		CONNECTOR, receptacle:
J1	9C87120	female; single contact
		COIL, RF:
L1	24B82890D10	coded CD2
L2, 3, 4	24B82890D03	coded CB5
L5	24B82890D11	coded CD3; incl. ref. part CR1
L6	24V80902A97	coded CD4; incl. ref. parts C4, C6, C10 and 76B82451B03 CORE, iron
		TRANSISTOR: NOTE 1
Q1	48R869108	P-N-P; type M9108
		RESISTOR, fixed: ±10%; 1/4 w; unl. stated
R1	6K128904	18K
R2	6K129231	3.3K
R3, 20	6K129432	820
NON-REFERENCED ITEMS		
	1V80728A45	HOUSING ASSY.: incl. ref part J1
	1V80721A84	TOP PLATE & TUNING COLLAR ASSY.
	29A832397	LUG, terminal: 2 used
	15B82533E01	COVER

REFERENCE SYMBOL	MOTOROLA PART NO	DESCRIPTION

TRANSMITTER

TLN6625A Power Amplifier EPD-8817-F

		CAPACITOR, fixed: uuf; unl. stated
C129	21K865054	13 ±5%; 500 v; N330
C130, 144, 147, 150	21C82187B04	270 ±10%; 500 v; X5F
C131, 132, 133, 138, 139, 142, 143, 161, 162, 163, 164, 165, 166	21B800801	1500 GMV; 100% max.; 500 v; Z5U
C134	21D82355B19	6 ±5%; 500 v; N470
C135	21K832520	3 ±0.25; 500 v; N470
C137, 140	21K865452	680 ±10%; 500 v; X5F
C141	19C82105G01	var.; 2.6-25 uuf; 850 v
C145	21C82372C02	0.2 uf +80-20%; 25 v
C146, 158, 159, 160	21K863801	250 ±10%; 350 v
C148	1V80728A78	assy.; var.; 4.2-15 uuf; 1600 v; incl. STRAP, plate
C149, 157	21K861219	1000 uuf; GMV; 500 v; coded RED
C151	21K859875	12 ±5%; 500 v
C152	19C82629E02	var.; 2.7-19.6 uuf; 750 v
C153, 155	21D82610C33	9 ±5%; 4KV; NP0
C154	21B82096G01	36 ±5%; 500 v; N80
C156	21K847874	12 ±5%; 500 v; NP0
C167	21K410063	10 ±5%; 500 v; NP0
		CONNECTOR, receptacle:
J101	9A87120	female; single contact
		COIL, RF:
L105	24B82118G01	CD5; incl. ref. part C129 and 1V80728A83 CORE ASSY., tuning
L106	24C82000E09	choke; 1.2 uh; sleeved
L107	24B82109G01	driver plate
L108	1V80731A25	PA grid; incl. shield & bracket
L109	24B82110G01	PA plate
L110	1V80728A81	antenna coupling
L111, 114	24V80900A86	choke; 1.02 uh; sleeved
L112, 113	24B82111G01	input & output; harmonic filter
L115, 116	1V80718B43	2 turns; sleeved
		RESISTOR, fixed: ±10%; 1/2 w; unl. stated
R132	6R6031	100K
R133	6R5775	680K ±5%
R134	6R5554	390
R135, 140	6R6427	27K; 1 w
R136, 141, 143, 148	6R6326	100
R137	6R5591	18K
R138	6R400228	1.5 meg ±5%
R142	6R6229	1K
R144	6R5576	4.7K; 1 w
R145	6R400228	1.5 meg ±5%
R146	6R5768	33K; 2 w
R147	6R6415	100; 1 w
R149	17C82177B15	4.5K; 7 w
R150	17K892469	4 ±2%; 1 w
		TRANSFORMER:
T101	24C82113G01	CD6; incl. ref. parts C134, C135, R138 and (2) 1V80728A83 CORE ASSY., tuning
		ELECTRON TUBE:
V101, 102	65A847[illegible]02	special purpose: tripler doubler driver
V[illegible]3	65A83735A01	special purpose: power amplifier
XV101, 102	9[illegible]11[illegible]01	SOCKET, electron tube: ceramic; 9 contact
XV[illegible]	[illegible]2[illegible]A1	steatite; 7 contact
NON-REFERENCED ITEMS		
	[illegible]V2[illegible]5A	SHIELD, heat dissipator
	[illegible]A01	SHIELD, tube
	A[illegible]230-3-1	SPRING, tube shield

TLN6619B Chassis Component Kit — EPD-10194-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uf; unl stated
C86	21K801139	.01 uf +80-20%; 600 v
C201	23D82178B04	3 section; c/o:
C201A		□ 750 +100-0%; 25 v
C201B		△ 600 +100-0%; 25 v
C201C		60 +100-0%; 25 v
C204	8D82122B04	2 section; c/o:
C204A		1.0 ±20%; 600 v
C204B		1.0 ±20%; 600 v
C204C		common
C205, 206, 207, 223	23D83550B02	50 +150-10%; 25 v; non-pol.
C210	23D82601A09	100 +150-10%; 25 v
C211, 212, 218	21K863147	150 uuf ±10%; 500 v
C214 thru 216	21K849338	40 uuf ±5%; 500 v; NP0
C217, 388, 389, 390	21D82428B06	.01 +70-30%; 100 v
C221	21B800801	1500uuf GMV; 100% max; 500 v
C222	21C82352C05	0.2; 25 v
C379	23K865136	15 ±20%; 25 v
C395	23D83210A08	100+150-10%; 25 v
		SEMICONDUCTOR DEVICE, diode: NOTE I
CR201, 203	48C82525G01	silicon
		CONNECTOR, receptacle:
J4, 102	9C880881	female; 11 contact
J401	28C82546E01	male; 29 contact
J5	9K85615	female; single contact does not incl 15A483599 HOOD
J402	9B84620C01	female; 24 contact
		COIL, RF choke:
L32	25B82878A04	70 mh
L202, 203	25C82227G01	40 mh
L204	25C82063G01	100 mh
L206	1V80718B43	2 turns
		CONNECTOR, plug:
P3	28A474006	male; single contact
		TRANSISTOR: SEE NOTE
Q208	48R869092	N-P-N; type M9092
		RESISTOR, fixed; ±10%; unl stated
R214	17C82036G05	0.27; 2 w
R216	6R6320	10K; 1/2 w
R217	6R2099	100K; 2 w
		BOARD, terminal
TB201	31R120965	3 ins. #3 gnd.
TB202	31R120174	1 ins. #2 gnd.
TB203	31R127617	5 ins. #2 gnd.
TB204	31R124448	4 ins. #3 gnd.
TB205	31R120364	1 ins. #1 gnd.
TB207	31S124445	3 ins. #1 mtg
		CABLE, RF:
W1	1V80729A63	assy.; incl. ref. parts J5, P3 and 30K475378 CABLE, RF: coaxial; RG/58AU; 8" req'd

TLN6644A Channel By-Pass Element
TLN6928A Channel By-Pass Element — EPD-8823-B

		CAPACITOR, fixed:
C368	21K840849	20 uuf ±5%; 500 v; NP0
NON-REFERENCED ITEMS		
	28C82992E02	CONNECTOR, male: 9 contact
	1V80771A18	COVER, connector (TLN6644A only)
	15A84912B01	BUTTON, push: blank (TLN6644A only)
	15A84911B01	COVER, connector (TLN6928A only)

TLN6627B Unit Component Kit — EPD-10196-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uuf
C97, 314	21K863147	150 ±10%; 500 v
C391	21K868996	1500; 100 v
		CONNECTOR, plug:
P2, 101	28A474006	male; single contact
		CABLE, RF transmission:
W2	1V80730A71	incl. ref. parts P2, P101 and 30A836551 CABLE, coaxial: RG-122/U 19" req'd 10M9401 BRAID, shield: 12" req'd

THN6042A Housing Kit — EPD-8825-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	15E82050E01	HOUSING, top
	15E82050E03	HOUSING, bottom

TLN6628B Diplexer Kit — EPD-10193-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed:
C385	21K840849	20 uuf ±5%; 500 v; NP0
		CONNECTOR, receptacle:
J2, 3	9C87120	female; single cont.
		COIL, RF:
L11	24A82666H01	winding
		CONNECTOR, plug:
P1	28A474006	male; single cont.
		COIL, assy:
Z2, 4	24C82705H01	resonator
Z3, 5	24C82705H02	resonator
NON-REFERENCED ITEMS		
	15B82750H01	COVER, diplexer: screened
	15D82738H01	HOUSING, diplexer
	3A8: 227A01	SCREW, special: 3 used

TLN6902A Unit Hardware Kit
TLN6903A Unit Hardware Kit — EPD-10670-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CONNECTOR, plug:
P402	28B851574	male; 24 contact
NON-REFERENCED ITEMS		
	55B83032A01	HANDLE, connector (P402)
	1V80739A74	PLATE ASSY., channel element hold-down
	41B82896H01	SPRING, decoder bracket (used on TLN6903A only)

NOTES:

I. Replacement transistors and diodes must be ordered by Motorola part number only for optimum performance.

II. Crystals are part of the radio set model only. If replacement is necessary, crystals must be ordered separately. When ordering xtal units specify car. freq. (s), xtal freq. (s) and xtal type no.

MOTOROLA

CAR TELEPHONE

FM TWO-WAY RADIO

IMPROVED MOBILE TELEPHONE SYSTEM

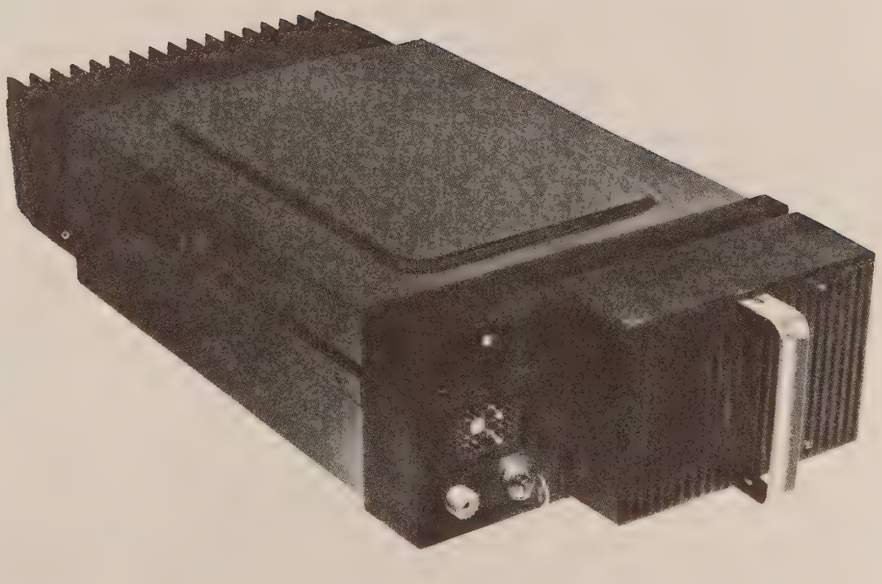
ELEVEN CHANNEL OPERATION

20 W RF POWER 152-162 MC

±12 VDC



Model TCN6070A Control Head



Model T1234A Car Telephone Radio Set

MOTOROLA INC. **Communications Division**

ENGINEERING PUBLICATIONS 1301 E. ALGONQUIN ROAD SCHAUMBURG, ILLINOIS 60172

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1/22/71-

68P81021A15
Issue - F

FOREWORD

SCOPE OF INSTRUCTION MANUAL

This manual offers descriptive and service information for the Motorola Car Telephone radio equipment described therein. Service diagrams are also supplied with the radio equipment and include the schematic, parts list, and printed circuit board details.

NOMENCLATURE

Motorola Car Telephone radio equipment is available in a choice of models to satisfy individual customer requirements. The radio set is specifically identified by the model number on the nameplate.

NOTE

Be sure to use the entire model number when making inquiries about your equipment.

PRODUCTION CHANGES

When production and engineering changes are incorporated into the equipment, a revision numeral is assigned to the chassis or kit affected.

Typical Example:
A Model TUD1090AB Chassis becomes TUD1090AB-1 with the first revision.

This chassis number complete with revision numeral if any, is stamped on the chassis at the time of production. The revision numeral becomes an integral part of the chassis identifier.

INSTRUCTION MANUAL REVISIONS

Changes which occur after an instruction manual is printed are described in the Instruction Manual Revisions. These bulletins give the reader complete information on the change including pertinent parts listing data.

NATIONAL SERVICE ORGANIZATION

Motorola provides a nation-wide service organization. Through its maintenance and installation program Motorola makes available the finest service to those desiring reliable continuous communications on a contract basis.



The largest service organization specializing in mobile communications is Motorola's National Service Organization. Over 800 strategically located, adequately staffed and trained, independently owned and operated stations, manned with several thousand FCC licensed personnel constitute the sub-contracting force.

The administrative forces of area and district service managers and district service representatives are in the direct employ of Motorola.

For your contract service requirements, please contact your local Motorola representative or write to:

National Service Manager
Motorola Communications Division
1301 E. Algonquin Rd.
Schaumburg, Illinois 60172

REPLACEMENT PARTS ORDERING

Motorola maintains parts and service depots and authorized service stations strategically located throughout the country. These facilities are fully equipped to give the finest service.

When ordering replacement parts, the complete number identification of the item must be used whether it be a component, kit or complete chassis. This will fix proper identification and insure receipt of the desired item. Complete number identification should also be used when requesting equipment information.

CAREFUL USE OF THE INSTRUCTION MANUAL AND THE MANY SUGGESTIONS CONTAINED IN IT WILL FURTHER INSURE PROPERLY INSTALLED AND MAINTAINED RADIO EQUIPMENT.

THE EQUIPMENT DESCRIBED IN THIS MANUAL IS MANUFACTURED UNDER ONE OR MORE OF THE FOLLOWING MOTOROLA U.S. PATENTS:

RE-24,815	2,834,879	3,059,184	3,204,202	3,306,990	3,387,270
RE-26,079	2,883,521	3,061,785	3,205,455	3,307,051	3,400,219
RE-26,361	2,888,652	3,070,737	3,218,587	3,307,121	3,409,841
2,626,384	2,899,547	3,070,748	3,223,953	3,323,065	3,414,881
2,637,782	2,901,601	3,083,332	3,233,243	3,324,408	3,416,032
2,650,333	2,912,573	3,087,117	3,234,469	3,327,215	3,424,854
2,688,059	2,918,571	3,087,998	3,247,475	3,328,695	3,424,983
2,691,094	2,924,705	3,087,999	3,250,997	3,328,727	3,430,171
2,691,560	2,925,562	3,091,736	3,250,999	3,333,151	3,431,486
2,699,425	2,938,082	3,094,293	3,256,497	3,333,911	3,437,838
2,705,281	2,963,577	3,101,441	3,263,172	3,334,293	3,437,934
2,731,555	2,966,585	3,119,093	3,273,083	3,335,405	3,441,854
2,738,466	2,974,221	3,126,514	3,275,938	3,336,533	3,447,133
2,740,891	2,984,740	3,128,431	3,281,697	3,341,777	3,448,342
2,743,361	2,994,844	3,129,396	3,284,714	3,345,568	3,449,680
2,759,052	3,009,115	3,131,354	3,289,098	3,345,569	3,453,521
2,759,103	3,014,127	3,149,317	3,292,085	3,345,573	3,454,927
2,777,950	3,027,454	3,175,183	3,293,644	3,348,148	3,458,664
2,799,010	3,027,455	3,175,187	3,300,723	3,355,533	3,465,294
2,808,507	3,039,081	3,175,193	3,304,501	3,355,709	3,469,191
2,809,236	3,041,550	3,183,382	3,304,503	3,369,597	3,471,796
2,830,200	3,048,659	3,191,123	3,305,779	3,370,236	3,471,805
2,833,994	3,048,747			3,373,379	3,473,152

Other U.S. Patents Pending

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REDUCTION OF INTERFERING NOISES IN MOBILE OPERATION 68P81001A82

MOTOROLA

MODEL CHART

FOR

CAR TELEPHONE EQUIPMENT

IMPROVED MOBILE TELEPHONE SYSTEM

NOTE: SOME VERSIONS USED TAD6120A.

CODE:

- [X] = ONE ITEM SUPPLIED.
- [/] = ONE ITEM SUPPLIED PER 5 OR LESS RADIO SETS.
- [O] = SUPPLIED AS REQUIRED.
- [■] = FULL COMPLEMENT (11 ELEMENTS) SUPPLIED.

* REPRESENTS A SERIES OF MODELS, SPECIFIC MODEL IS DETERMINED BY CHOICE OF COLOR.

MODEL	DESCRIPTION	RADIO UNIT TLD1100A	CHANNEL ELEMENTS TLD1010A	CHANNEL BYPASS ELEMENTS TLN6928A	CONTROL HEAD (BELL SYSTEM) *TCN6060A	CONTROL HEAD *TCN6070A	CONTROL HEAD MOUNTING KIT TLN6971A	SUPERVISORY UNIT TLN1034A	CABLE KIT (NEGATIVE GROUND) TKN6142C	CABLE KIT (NEGATIVE GROUND) TKN6144A	ANTENNA (SEE NOTE) TAD6113A	HARDWARE KIT (FOR EXTERNAL SUPERVISORY UNIT) TLN6902A	TUNING TOOLS TLN6629B	NAMEPLATE (BELL SYSTEM) TLN6888A	NAMEPLATE TLN6889A	CONTROL HEAD (REVERTIVE) *TCN6090A	RADIO UNIT (REVERTIVE) TLD1220A	CONNECTOR HOUSING KIT TLN6969A
T1234A	RADIO UNIT ONLY FOR BELL SYSTEM APPLICATIONS	X	O	O						X	X	X	/	X				X
T1245A	IMTS MOBILE UNIT FOR BELL SYSTEM APPLICATIONS (LESS CONTROL UNIT	X	O	O				X	X	X			/	X				X
T1246AH	IMTS MOBILE UNIT FOR BELL SYSTEM APPLICATIONS (WITH CONTROL UNIT)	X	O	O	X		X	X	X		X		/	X				
T1258AH	IMTS MOBILE UNIT (WITH CONTROL UNIT AND FULL 11 CHANNEL COMPLEMENT)	X	■			X	X	X	X		X		/		X			
T1262AH	IMTS MOBILE UNIT (WITH CONTROL UNIT AND CHANNEL ELEMENTS AS REQUIRED)	X	O	O		X	X	X	X		X		/		X			
T1278AH	IMTS MOBILE UNIT (WITH REVERTIVE CONTROL UNIT AND FULL 11 CHANNEL COMPLEMENT)		■				X	X	X		X		/		X	X	X	
T1279AH	IMTS MOBILE UNIT (WITH REVERTIVE CONTROL UNITSAND CHANNEL ELEMENTS AS REQUIRED)		O	O			X	X	X		X		/		X	X	X	
T1284A	IMTS MOBILE UNIT FOR BELL SYSTEM APPLICATIONS (LESS CONTROL UNIT)	X	■							X	X	X	/	X				
T1285A	IMTS MOBILE UNIT FOR BELL SYSTEM APPLICATIONS (LESS CONTROL UNIT)	X	■					X	X		X		/	X				
T1285AH	IMTS MOBILE UNIT FOR BELL SYSTEM APPLICATIONS (LESS CONTROL UNIT)	X	■					X	X		X		/	X				
T1286AH	IMTS MOBILE UNIT FOR BELL SYSTEM APPLICATIONS (WITH CONTROL UNIT AND FULL 11 CHANNEL COMPLEMENT)	X	■		X		X	X	X		X		/	X				

EPD-10588-F

MOTOROLA

BELL SYSTEM NOMENCLATURE

VERSUS

MOTOROLA MODELS

CODE:

- [X] = ONE ITEM SUPPLIED
- [/] = ONE ITEM SUPPLIED PER FIVE (OR LESS) RADIO SETS
- [O] = AS REQUIRED

BELL SYSTEM MODEL	DESCRIPTION	MOTOROLA MODEL	TLN1034A	TLD1100A	TLN6888A	TLN6928A	TLN6629B	TKN6144B	TKN6142C	68P81107A52	TKN6194B	TKN6178B	TLD1010A	TLD1012A	TLD1018A	TLD1013A	TLD1019A	TLD1016A	TLD1017A	TLD1015A	TLD1021A	TLD1020A	TLD1011A	TLD1014A	TAD6120A	TKN6199A	68P81108A86	TLN6906A	68P81108A88	TLN6902A
KS19609-L2	SUPERVISORY UNIT ONLY		X																										
KS19609-L3	RADIO UNIT, BY-PASS ELEMENTS; TUNING TOOLS			X	X	O	/																						
KS19609-L4	CABLE KIT, 20', NEGATIVE GND, HOUSING & COVER							X																					
KS19609-L5	CABLE KIT, 20', NEGATIVE GND; HOUSING & COVER INSTRUCTION SHEET								X	X																			
KS19609-L7	TUNING TOOLS						X				X																		
KS19609-L8	CABLE KIT, 20', POSITIVE GND; HOUSING & COVER											X																	
KS19609-L9	CABLE KIT, 20', POSITIVE GND, HOUSING & COVER, INSTRUCTION SHEET									X																			
KS19609-L10	CHANNEL BY-PASS ELEMENT (DUMMY ELEMENT)					X																							
KS19609-L11	SERIES: CHANNEL ELEMENTS												O																
KS19609-L11	JL CHANNEL ELEMENT													X															
KS19609-L11	YL CHANNEL ELEMENT														X														
KS19609-L11	JP CHANNEL ELEMENT															X													
KS19609-L11	YP CHANNEL ELEMENT																X												
KS19609-L11	YJ CHANNEL ELEMENT																	X											
KS19609-L11	YK CHANNEL ELEMENT																		X										
KS19609-L11	JS CHANNEL ELEMENT																			X									
KS19609-L11	YS CHANNEL ELEMENT																				X								
KS19609-L11	YR CHANNEL ELEMENT																					X							
KS19609-L11	JK CHANNEL ELEMENT																						X						
KS19609-L11	JR CHANNEL ELEMENT																							X					
KS19609-L12	ANTENNA																								X				
KS19609-L14	CABLE ADAPTER																									X			
KS19609-L15	ADAPTER PLUG; INSTRUCTION SHEET																									X	X		
KS19609-L16	UNIT HARDWARE KIT																											X	X

EPD-109

DESCRIPTION

1. INTRODUCTION

The Motorola car telephones described in this manual provide the user with car telephone service within improved mobile telephone system (IMTS) and mobile telephone service (MTS) areas. All units operate in the 152-162 mc band with 20 watts of r-f power and include the following features.

a. Eleven channel capability.

b. Full duplex (simultaneous receive and transmit) operation.

c. Automatic channel searching in multi-channel IMTS areas.

d. Mobile identification and mobile dialing in IMTS areas.

e. Fully compatible operation in present MTS areas.

f. High level of reliability achieved by:

- using extensively transistorized circuitry with regulated supply.
- providing over voltage regulation and controlled tube heater warm-up (surge protection). This limits the current and voltage applied to the transmitter tube filaments for extended tube life.
- eliminating all relays which introduce long term maintenance problems.

The items comprising the car telephones are summarized on the Model Chart at the front of this manual. The radio set, supervisory unit, and control head are described fully in other sections of this manual. An overall ±12 Volt Functional Block Diagram (69D81022A69) is included in this section for convenience. The functions of the blocks are described thoroughly in appropriate sections of this manual (see Contents).

2. APPLICATION

The car telephones described in this manual, can be used in all vehicles equipped with either a positive or negative ground 12-volt system by using an appropriate cable kit. For specific applications, refer to the Model Chart. The equipment operates in any IMTS area having one to eleven channels and all present MTS areas. Direct dialing (same as a standard telephone) with duplex operation can be performed in all IMTS areas (home or foreign). In a home IMTS area, the available (idle) channel in the complement is marked at the exchange and automatically selected by the car telephone. In foreign multi-channel IMTS areas, the mobile caller first selects the channels available in the area by pressing the channel select buttons on the control head. Then, the operation is the same as for home IMTS areas.

Manual connections (through the exchange mobile operator) are used in all present MTS areas. In this application, the desired channel is selected by operating the appropriate channel button on the control head. This mode of calling is similiar to standard telephoning except that the handset push-to-talk button is pressed to alert the operator and again when talking to the party.

3. SYSTEM DESCRIPTION

a. General

Car telephone service is effected via FM radio on frequencies specifically allocated for this service. The radio network basically consists of a car telephone unit and a base station connected to a telephone exchange. The mobile radio subscriber is afforded full telephone service in that he may call any number including other mobile radio subscribers. Direct dialing with full duplex operation in IMTS areas and manual calling with duplex operation in present MTS areas is provided by the radio equipment and the telephone exchanges.

With multi-channel IMTS operation (automatic operation) and eleven channels available, maximum capability for finding a clear channel on which to initiate a call is afforded the mobile telephone subscriber. Channels are automatically selected by the car telephone equipment. Within MTS areas, provision for up to eleven channel operation is also afforded the mobile telephone subscriber. Channels are selected by pushing the appropriate button on the control head which is marked to indicate the channel.

Each mobile unit is assigned a number and only the unit of the called mobile is made to ring. Assigned numbers are established by jumper wires on the car telephone radio set selector unit. Incoming calls are announced by a bell ringer in the control head. Auxiliary alarm facilities are also provided for activating an external alarm (horn, headlights, etc). If the auxiliary alarm is in use, it will also indicate an incoming call. Removing the handset from its

holder automatically de-energizes the ringer and the auxiliary alarm. If the incoming call is not answered within a 45 second time limit, the bell ringer and the auxiliary alarm are de-activated by the telephone exchange.

A green lamp on the control head illuminates when the transmitter is on. During this time, the receiver remains on (duplex operation) to allow the subscriber to hear the other party.

To prevent unauthorized personnel from operating the car telephone, the d-c operating power is turned off by a key-lock switch located on the control head. Illumination of this switch provides a power on indication.

b. Automatic Mode of Operation

(1) Marked Idle Channel

When one or more unused radiotelephone channels are available in a particular area, one is automatically selected at the telephone exchange. The base station then transmits an idle tone on that channel and it is "marked" idle. The mobile units, when turned on, hunt over each channel in their complement, detect the presence of the idle tone, and select that channel.

(2) Mobile to Base Call

If the mobile is resting on an idle channel when the subscriber goes "off-hook" to originate a call, it transmits a guard tone and then a connect tone. The receipt of the connect tone causes the base station to remove the idle tone from the channel and to mark a new channel idle. As a result, all mobiles now proceed to search for the new marked idle channel except that the mobile originating the call is prevented from searching while transmitting. The base station now transmits a seize tone and when this tone is removed, the mobile identifies itself by sending a connect tone interrupted by a guard tone after each even numbered pulse and unmodulated carrier after each odd numbered pulse. When identification is completed, the handset is unmuted and a dial tone is received from the base station. Once the dial tone is received, dialing can begin.

Dialing is accomplished by alternately interrupting the guard tone with a connect tone. After dialing is completed and the called party answers, conversation may follow.

When the subscriber goes "on-hook" after the call is completed, the mobile transmits a disconnect signal indicating a vacant channel. The mobile is then unlatched and it proceeds to hunt for the new idle channel in preparation for the next call.

(3) Base to Mobile Call

When a call is received at the telephon exchange and identified by the control equipment as being for a mobile unit, it is fed to the marke idle channel. The base station then replaces th idle tone with seize tone and marks a differen channel idle. The mobile units previously lock- ed on channel by the idle tone now use the seize tone as a latch. The base station then outpulses the calling code of the desired mobile. The cod is transmitted by interrupting the seize tone with pulses of idle tone.

After correctly receiving its calling code, the mobile transmits an acknowledge signal to the base station which indicates reception of the code. The base station then sends alternate idle and seize tone tone pulses to actuate the ringer in the control head, alerting the subscriber. When the subscriber goes "off-hook" in answer to the incoming call, the mobile transmits the connect tone. The base station then removes the ringing signals and conversation may begin.

After the call is completed and the hand set is hung up, the mobile transmits a disconnec signal. This signal informs the base station tha the channel is unoccupied. The mobile is then unlatched and channel hunting begins as previously described.

If a wrong number is received for any of the digits in the mobiles calling code a mismatch occurs in all units except the selected mobile. This mismatch causes the mobile to search for the new marked idle channel.

When the call to the selected mobile is left unanswered (ringing continues for 45 seconds), the seize tone is removed from the channel and the mobile begins its search for the new marked idle channel.

(4) Busy Conditions

If the subscriber goes "off-hook" while the mobile is not locked on an idle channel or while it is receiving a signal from the base station, the BUSY lamp on the control head lights and the handset remains muted. If the channel is idle at the time of "off-hook", but (a) idle tone is lost before connect tone is transmitted (channel seized by another mobile) or (b) idle tone is not lost while connect tone is being transmitted (mobile transmission not received by the base station), the BUSY lamp lights, the call attempt is blocked, and the mobile begins to search for the new idle channel.

c. Manual Mode of Operation

In the manual mode of operation, all tone signalling (600 and 1500 cps) originates from the

base station. When a predetermined sequence of tones is received, the ringer in the control head is turned on. This alerts the subscriber that a call is being directed to the mobile. The ringer operates continuously until the handset is removed from its holder in answer to the call, or until a reset pulse is transmitted from the base station.

A mobile call is initiated by contacting the mobile service operator at the telephone exchange. The radio transmitter is turned on only when the push-to-talk button on the handset is pressed. During this time, the receiver remains on (duplex operation) to allow the subscriber to hear the other party. An illuminated green lamp on the control head indicates the transmit condition.

4. SPECIAL PURPOSE KITS

a. TKN6178B Cable Kit

This cable kit is for use with radio units having internal supervisory units when used in positive ground installations.

b. Model TKN6194B Cable Kit

This kit is used when a Secode supervisory unit is used in a positive ground system.

c. TEN6054B Alignment Cable Kit

This kit provides the cabling and adapters necessary for receiver alignment.

d. TEN6055A Test Set Adapter

This adapter must be used when aligning or checking the radio set with a Motorola Portable Test Set. It adapts the test set for use with the radio set.

e. TEN6056A Duplex Sensitivity Measurement Adapter

This kit enables measurement of receiver sensitivity while the transmitter is in operation.

f. TEN6058A Radio Servicing Kit

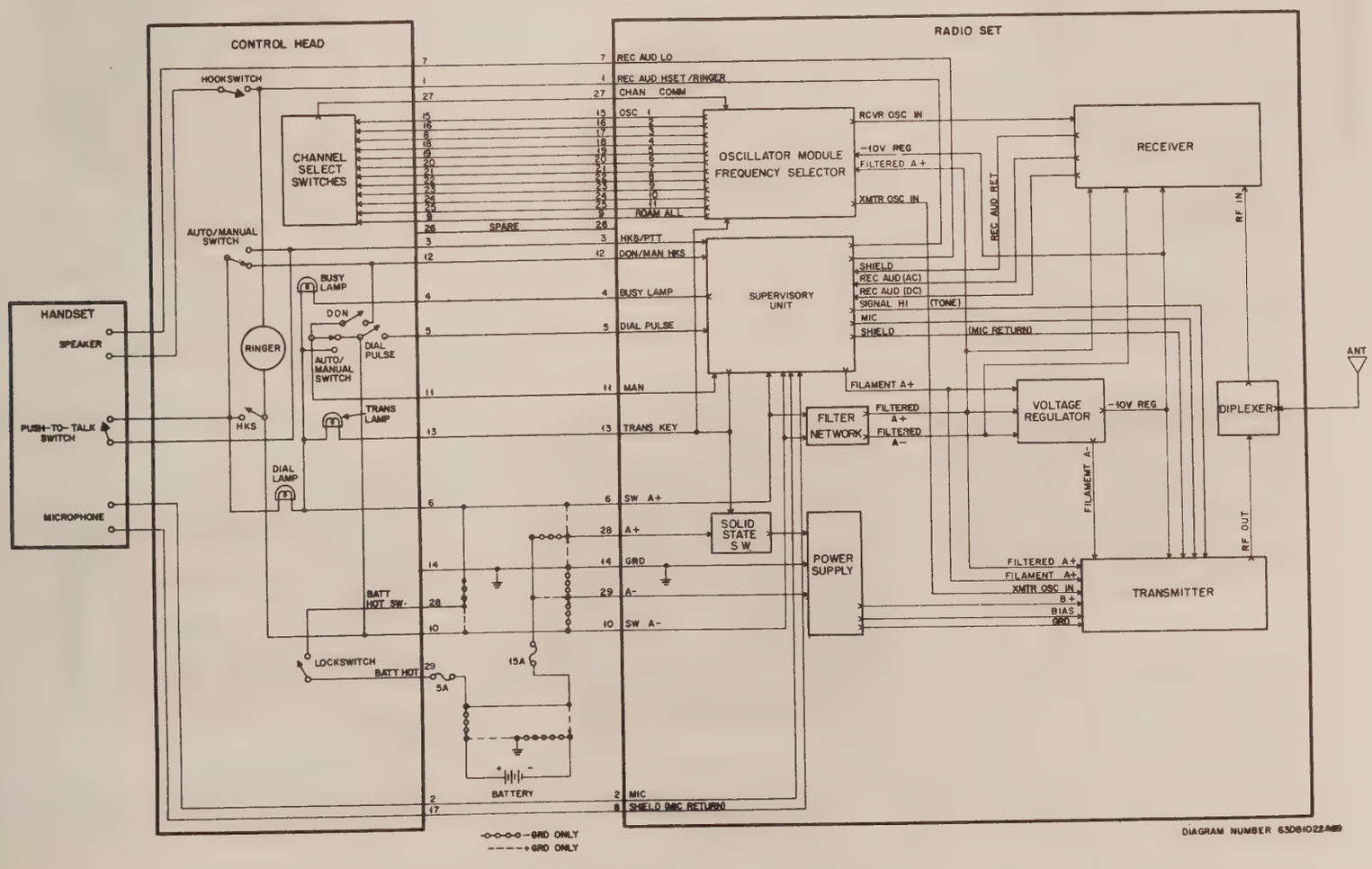
This kit includes the Models TEN6054B, TEN6055A and TEN6056A Kits previously described.

g. THN6045A Weatherproof Housing

This housing offers maximum protection to the radio set under the most adverse weather conditions.

h. TLN6588A Mounting Kit

This kit is used for mounting the radio set to the raised shelf in the vehicle trunk.

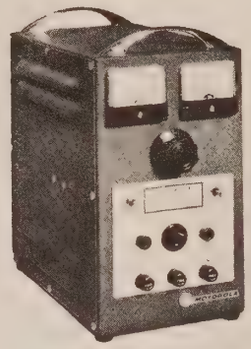


±12 Volt Functional Block Diagram

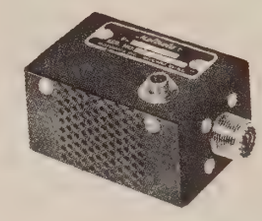
RECOMMENDED TEST EQUIPMENT



S1059*
PORTABLE TEST SET



T1012A**
POWER SUPPLY



P-7208
DUMMY LOAD



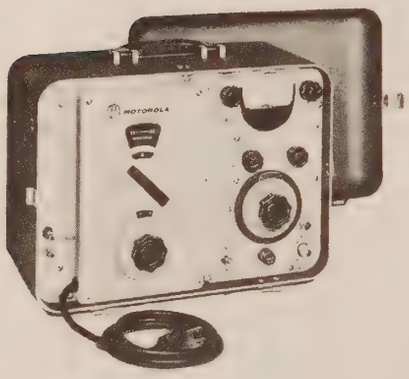
TRANSISTORIZED
DC MULTIMETER



TRANSISTORIZED
AC VOLTMETER



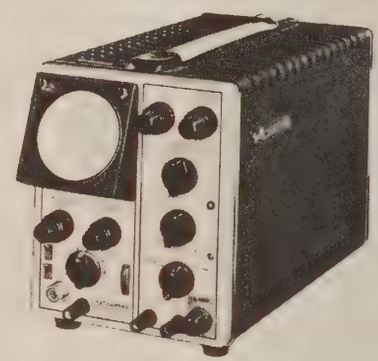
TEK-31
TRANSISTORIZED TONE
GENERATOR



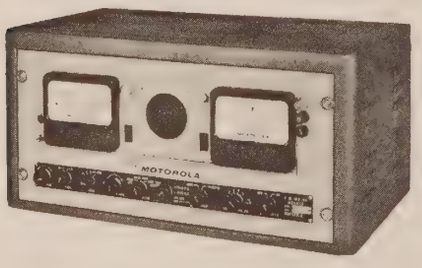
T1034C
SIGNAL GENERATOR



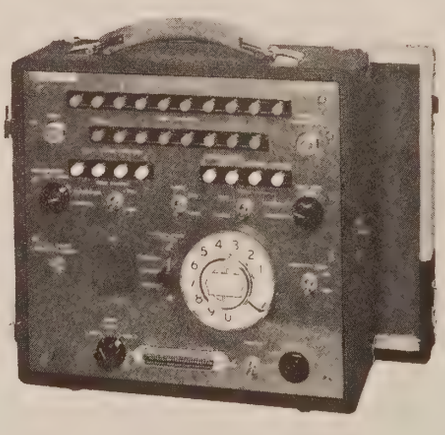
S1068A
FREQUENCY CALIBRATOR



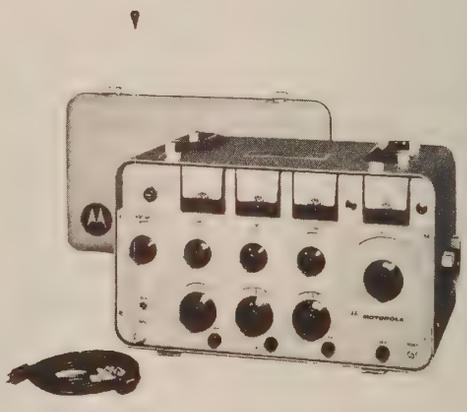
T1014B
PRECISION WIDE BAND
OSCILLOSCOPE



T1130A SERIES
FM STATION MONITOR



T1257A
SUPERVISORY UNIT
TEST SET



T1021A
PORTABLE FREQUENCY
METER

* For use with Motorola Car Telephone radio sets, order TEN6055A Test Set Adapter.
** For use with Motorola Car Telephone radio sets, use TEK-15A Ripple Filter.

INSTALLATION AND OPERATION

1. INSTALLING THE RADIO SET

Complete installation instructions are packed with the radio set.

2. OPERATOR'S INSTRUCTIONS

CAUTION

Before operating the radio set, recheck the polarity of the power source and cable kit.

a. Turning On the Equipment

Turn the key-lock switch on the control head to the ON position. The switch will illuminate to indicate that power is being applied to the equipment. Allow a 45 second warm-up period before operating the equipment.

NOTE

Before any extended conversation is attempted, the engine of the vehicle should be running to conserve the battery.

b. Operation

(1) Home Mode

The home mode provides automatic duplex operation in single or multi-channel home IMTS areas. The channel for the next radiotelephone call is automatically selected.

(a) Initiating a Call

1. Make sure the H button on the control head is depressed.

2. Remove the handset from its holder. The TRANS light should come on. If the TRANS light does not come on, the channel is busy and the BUSY light will come on. If the channel is busy, hang up the handset and try again after a few seconds.

3. When the dial tone is received, dial the number of the party to be called in the same manner as with a standard telephone.

4. When the called party answers, conduct the conversation in a normal voice (it is not necessary to press the push-to-talk button on the handset).

5. At the end of the call, return the handset to its holder.

(b) Answering a Call

1. An incoming call is indicated by the control head ringer. When the ringer sounds, pick up the handset (the TRANS light will come on) and answer in a normal voice (it is not necessary to press the push-to-talk button on the handset).

2. At the end of the call, return the handset to its holder.

(2) Roam Mode

The roam mode provides automatic duplex operation when the equipment is used in single or multi-channel foreign areas where IMTS base station equipment exists. The channel for the next radiotelephone call is automatically selected.

(a) Initiating a Call

1. Make sure the R button on the control head is depressed.

2. Press the proper channel select buttons for the channels in the particular area.

3. If the channels are not known, contact the mobile service operator and ask for a list of the assigned channels in the particular area. To contact the mobile service operator, remove the handset from its holder, wait for the dial tone, then, dial the operator and ask for the mobile service operator. Follow the instructions given and return the handset to its holder.

4. When the proper channel buttons have been pressed, proceed by removing the handset from its holder. The TRANS light should come on. If the TRANS light does not come on, the channel is busy and the BUSY light will come on. If the channel is busy, hang up the handset and try again after a few seconds.

5. When the dial tone is received, dial the number of the party to be called in the same manner as with a standard telephone. If an operator answers in place of the dial tone, give her your number and place of registry as well as the number you are calling.

6. When the called party answers, conduct the conversation in a normal voice (it is not necessary to press the push-to-talk button on the handset).

7. At the end of the call, return the handset to its holder.

(b) Answering a Call

1. An incoming call is indicated by the control head ringer. When the ringer sounds, pick up the handset (the TRANS light will come on) and answer the call in a normal voice (it is not necessary to press the push-to-talk button on the handset).

2. At the end of the call, return the handset to its holder.

(3) Manual Mode

The manual mode provides a non-automatic operation in the MTS areas. The desired channel is selected by pressing the appropriate button on the control head.

(a) Initiating a Call

1. Make sure the M button on the control head is depressed.

2. Select a channel from which to initiate the call by pressing the appropriate channel select button.

3. Remove the handset from its holder. The dial will become illuminated. Monitor the channel to be sure it is clear and not in use. If the channel is busy, change channels until a clear one is found.

4. Press the push-to-talk button on the handset for approximately two (2) seconds and release it. Then, wait for the mobile operator to answer. The TRANS light will come on when the push-to-talk button is pressed.

5. When the mobile operator answers, press the push-to-talk button and give the operator your place of registry and number as well as the number you are calling.

6. When the called party answers, press the push-to-talk button and conduct the conversation in a normal voice. The receiver remains operative while the transmitter is "on-the-air" (duplex operation) which allows the push-to-talk button to be held down during the conversation if desired. However, if the received signal is weak or noisy, releasing the push-to-talk button when listening may increase the clarity of the signal.

7. At the end of the call, return the handset to its holder.

(b) Answering a Call

1. An incoming call is indicated by the control head ringer. When the ringer sounds, pick up the handset, press the push-to-talk button (the TRANS light will come on), and answer the call in a normal voice. The receiver remains operative while the transmitter is "on-the-air" (duplex operation) which allows the push-to-talk button to be held down during the conversation if desired. However, if the received signal is weak or noisy, releasing the push-to-talk button when listening may increase the clarity of the signal.

2. At the end of the call, return the handset to its holder.

(4) Revertive Mode (with TCN6090 series Control Units only)

The revertive mode is used when a mobile to mobile call is initiated in a single channel IMTS system.

(a) Calls in this mode are initiated as in either the "home" or "roam" modes. After the number has been dialed, either a recorded message or a distinctive tone will be heard by the calling party as notification that a revertive call has been made.

(b) The caller will then depress the P (party) button on the control head. With the P-T-T button released, the calling mobile transmitter will go off and the called party will be rung at this time.

(c) When the called party answers, the same recorded message or distinctive tone will be heard by both parties.

(d) After the called party has depressed the P (party) button, the call is completed on a push-to-talk basis.

(e) When the call has been completed both parties must return the handsets to their cradles to return the system to the automatic modes.

c. Auxiliary Ringing

To activate the auxiliary ringing features, press the AUX button on the control head. Then, whenever a call is received, the control head ringer and an auxiliary call indicator (horn, headlights, etc.) will operate. The auxiliary call indicator will be turned off when the handset is picked up. Pressing the AUX button a second time deactivates this function.

d. Turning Off the Equipment

Turn the key-lock switch to the OFF position. The illumination around the switch will go out to indicate that power has been removed from the equipment.

DESCRIPTION

1. INTRODUCTION

The car telephone radio set described in this section operates in the 152-162 mc frequency range with an r-f output of 20 watts. It provides the receiving and transmitting facilities for "Improved Mobile Telephone Systems" (IMTS).

The Model TLD1100A Radio Set consists of:

THN6042A	Housing Kit
TLN6042A	Installation Kit
TUD1160AB	Unified Radio Unit
TLN6619B	Chassis Assembly Kit
TLN6620B	Channel Element Socket Board (See Note)
TLN6621B	1st IF (5.26 MC) Kit
TLN6622B	Multipler and Audio Board Kit
TLN6623B	455 KC Board Kit
TLN6624B	2nd Oscillator (5.715 MC) Kit
TLN6625A	Power Amplifier
TLN6627B	Miscellaneous Parts and Hardware Kit
TLN6628B	Diplexer Kit
TLD6290B	Receiver RF Deck Kit
TFN6018AS	Receiver Filter
TLD6300B	Exciter Board Kit
TPN6046A	Power Supply and Regulator

NOTE

Each of the sockets on the Channel Element Socket Board (TLN6620B) should be occupied by either a Channel Element (TLD1010A Series) or a Channel By-Pass Element (TLN6928A).

2. DIPLEXER

The diplexer is a frequency selective filter. It permits simultaneous operation of the transmitter and receiver using a single antenna.

3. TRANSMITTER

The transmitter is a multi-frequency unit which can operate on any of eleven crystal-controlled frequencies within the 152-162 mc band. It provides 20 watts of r-f power output and except for a tripler, doubler-driver, and power amplifier stage is completely transistorized. An IDC ("Instantaneous Deviation Control") circuit is incorporated for setting and maintaining transmitter deviation. In addition, facilities are also incorporated (4 pin terminals and a jumper wire) for adjusting the audio sensitivity of the handset microphone audio amplifier. This adjustment is used to compensate for speech level and microphone output variations. Refer to paragraph 2.c. under SERVICE AIDS for sensitivity adjustment instructions.

4. RECEIVER

The receiver (double-conversion superheterodyne type) is completely transistorized and accepts FM signals within the 152-162 mc band. It includes a crystal-controlled non-ovenized second oscillator and an r-f pre-selector (resonant cavities) which may be tuned for maximum interference rejection. In addition, provisions are also incorporated for conversion to simplex operation. For conversion details, refer to paragraph 3.c. under SERVICE AIDS.

5. POWER SUPPLY

The power supply is fully transistorized and uses silicon diode rectifiers for greatest reliability. It provides all the operating voltages for the transmitter and for the voltage regulated circuits in the receiver. In addition, it includes circuitry for controlled heater warm-up (surge-protection) and over voltage regulation. This limits the voltage and current to the transmitter tube filaments for extended tube life. Except for

68P81021A16-B

ANTEED PERFORMANCE SPECIFICATIONS

ERAL

CLE POWER SOURCE	±12 V DC
QUENCY	152-162 mc
ERING	Motorola Portable Test Set can be used to measure all circuits essential to tuning and checking through central metering plug. (A single scale, 0-50 ua meter can also be used.)
BER OF CHANNELS	Maximum of 11. (Specify desired channels when ordering.)
ER SUPPLY	Fully transistorized
RAGE BATTERY DRAIN 3.7 VOLTS DC)	Standby -- Less than 2 amps Transmit -- Less than 10 amps
NSIONS	11" wide x 22-1/2" long x 5" high
HT	44 pounds

NSMITTER

MUM RF POWER OUTPUT	20 watts (into antenna terminals, including diplexer loss)
PUT IMPEDANCE	50 ohms
DUCTED SPURIOUS MONIC EMISSIONS	more than 90 db below carrier
O DISTORTION	less than 5% at 1000 cps, ±3.3 kc deviation
QUENCY STABILITY	±0.0005% of assigned carrier frequency from -30°C to +60°C ambient (+25°C reference)
O RESPONSE	+1, -3 of 6 db/octave pre-emphasis characteristic from 300-3000 cps
ULATION	15F2 and 16F3: ±5 kc for 100% at 1000 cps
OISE	50 db below ±3.3 kc deviation at 1000 cps

EIVER

NNEL SPACING	30 kc
CTIVITY B QUIETING)	-100 db at ±15 kc
ULATION ACCEPTANCE	±7 kc
ITIVITY B QUIETING)	0.7 microvolt (at antenna terminals including diplexer insertion loss)
QUENCY STABILITY	±0.0005% of reference frequency from -30°C to +60°C ambient (+25°C reference)
RIOUS AND IMAGE CTION	greater than 85 db measured by limiter current (20 db quieting reference).
NPUT IMPEDANCE	nominal 50 ohms

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE
FCC LICENSE DESIGNATION: CC3031

the filtering components, the entire power supply is contained in a metal housing which also serves as a heat sink for the power supply transistors.

6. OSCILLATOR MODULE SOCKET BOARD

The oscillator module socket board is a printed circuit board which comprises the following items:

a. Completely transistorized plug-in oscillator modules. These modules generate the r-f frequencies (13.1475 to 13.1725 mc) which are used to feed the transmitter modulator stage and the receiver first oscillator multiplier board. One module (channel element) is provided for each channel and each fixes a specific transmit and receive frequency. The following table correlates the channel element kits, telephone channel designations, and frequencies.

Channel Element	Channel	Transmit (mc)	Receive (mc)
TLD1011A	JK	158.04	152.78
TLD1012A	JL	157.77	152.51
TLD1013A	JP	157.83	152.57
TLD1014A	JR	158.07	152.81
TLD1015A	JS	157.95	152.69
TLD1016A	YJ	157.89	152.63
TLD1017A	YK	157.92	152.66
TLD1018A	YL	157.80	152.54
TLD1019A	YP	157.86	152.60
TLD1020A	YR	158.01	152.75
TLD1021A	YS	157.98	152.72

b. A switching circuit that includes a ring stepper and associated control circuitry. The ring stepper circuit is contained within the plug-in module housing and is used for switching to the selected channel element. It is a circuit that simulates a stepping switch. When a pulse of specific magnitude and polarity is applied to the ring stepper the channel element located in the next higher numbered board socket is activated.

The control circuitry provides the pulse to the ring stepper (when warranted) for channel switching. Pulses are provided by this circuitry until the selected channel element is activated. The channel element is selected by pushing its associated pushbutton on the control head.

c. A transistorized buffer-amplifier and limit stage. The buffer-amplifier receives its inpu from the selected channel element and provides an output to both the receiver first oscillator multiplier board and to the limiter. The limiter in turn, provides an output to the transmitter modulator stage.

7. HOUSING

The housing is a heavy gauge steel cabinet with a removable top for access to the compon ents mounted on the radio chassis contained with in. The transmitter, receiver power supply, diplexer and selector assembled together form drawer unit which slides into the housing. The power supply, except for the filtering componen is contained in a separate housing which mount to the front panel and includes a chrome plated carrying handle. All external and most metering connections are made through receptacles on the front panel. Two metering receptacles are located under a protective nameplate cover and ar used to connect the Motorola Portable Test Set necessary to align and check the transmitter and receiver. The housing is non-vented to preven dust and dirt from entering the radio set. The voltages involved in high power vacuum tube stages cause dust and dirt particles to become ionized and cling to various tuned elements. Th would degrade performance and cause unnecessa maintenance. Heat sinks are used to dissipate th heat generated by the transmitter and power supp

The radio set housing is mounted in the tru and remotely controlled by means of a dash- mounted control head. A key-lock-switch is als provided to secure the drawer assembly from u authorized persons. Refer to the SERVICE AIDS for instructions on the removal of individual com ponents.

8. INSTALLATION AND OPERATION

Complete installation instructions are packe in the shipping carton with the radio set. Oper- ating instructions are found in the INSTALLATI AND OPERATION section of this manual.

THEORY OF OPERATION

OSCILLATOR MODULE SOCKET BOARD

Introduction

The oscillator module socket board provides
lities for electronically switching the mobile
io set to any one of eleven radio channel fre-
ncies. It consists of a fast astable control cir-
, slow and fast astable multivibrators, diode
e, drive amplifier, plug-in channel elements,
er amplifier, and limiter (see figure 1). The
-in channel elements each house a transistor-
l oscillator circuit with an unheated crystal
a circuit for selecting the channel element.
buffer-amplifier stage receives its input from
selected channel element and provides an out-
to the limiter and the receiver first oscillator
tiplier board. The limiter in turn feeds an out-
to the transmitter modulator stage.

Eleven nine pin sockets are located on the
d and each is used to accommodate a plug-in
nel element. Refer to the Oscillator Module
et Board Detail (EPD-9972) for socket loca-
These sockets are identified one through
en and each corresponds to its respective
button on the control head (refer to figure 1).
less than eleven channel operation, channel
ass elements (dummy elements) are provided
placement into the unoccupied sockets.

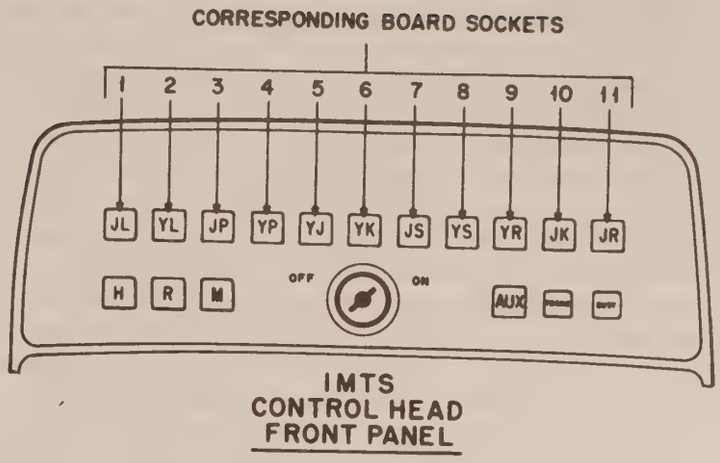


Figure 1.
Control Head Pushbutton-Socket
Number Designation

b. Functional Description

The basic function of the oscillator module socket board is to provide the proper oscillator frequency for the receiver and transmitter as selected by the supervisory unit in the automatic modes (home and roam) or the control head channel button in the manual mode. Each crystal controlled oscillator and its associated on-off circuitry is contained in a channel element module which plugs into the socket board.

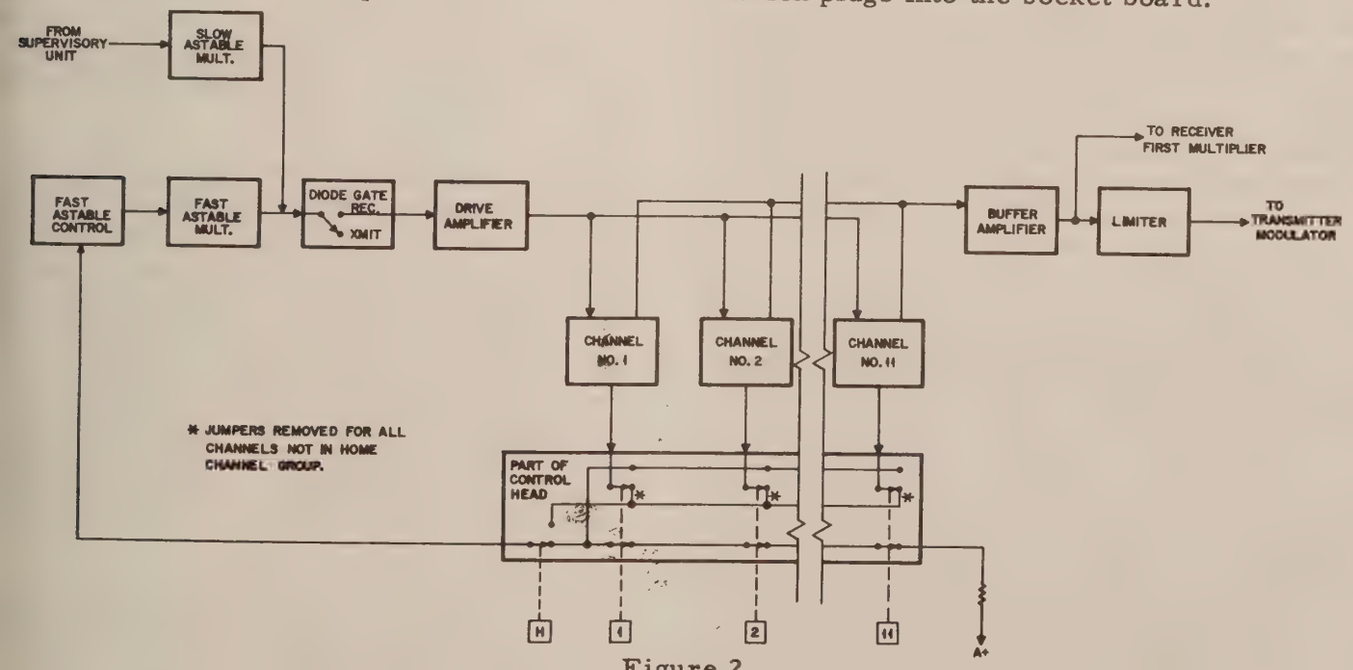


Figure 2.
Oscillator Module Socket Board Functional Block Diagram

When a new channel is selected, either by placing idle tone on a new channel in the automatic modes or pushing a new channel button in the manual model, the channel element that was previously on will turn off. This in turn, causes the next channel element to turn on. If it is not the selected channel, it will turn off turning the next channel element on. This process is repeated until the selected channel turns on. The rate at which the channel elements are turned on and off in sequence is relatively slow in the automatic modes (4 cps slow astable) since the supervisory unit must detect the presence or absence of idle tone before deciding whether or not the channel that is on is the selected one. In the manual mode, however, the rate is much faster (500 cps fast astable) since the selected channel is immediately determined by pushing in the channel button.

c. Circuit Description

(1) Introduction

The important characteristics of transistors employed in switching circuits differ from those employed in the r-f or i-f stages of a radio.

A transistor switch has high resistance in one state and a low resistance in the other. Transistors can be used as switches if they are operated under non-conducting (cut-off) or fully saturated (on) conditions. If the emitter to base junction of a germanium transistor is unbiased or reversed biased, the transistor is cut-off and the collector junction becomes a high resistance. Heavy forward biasing of the emitter to base junction drives the transistor into saturation. The collector junction becomes a low resistance and the collector potential approaches the emitter potential.

(2) Astable Multivibrator

The astable multivibrator (figure 3) is a free running relaxation oscillator. It consists of two collector-coupled P-N-P transistor stages which operate as follows:

Because of transistor unbalance and variations in component tolerances, one transistor will conduct more heavily than the other when the initial d-c power is applied. Let us assume that Q302 conducts more heavily than Q303 at turn on. This causes the collector voltage of Q302 to become more positive. This positive going voltage, coupled to the base of transistor Q303 by C334, decreases its forward bias. With its forward bias decreased, the potential at the collector of Q303 decreases and this negative going voltage is plied to the base of Q302 via C335, driving further into saturation. This action continu until Q303 is cut-off and Q302 is saturated. that time, C334 charges and causes a forw bias to be established at the base emitter jun of transistor Q303. Transistor Q303 then be to conduct and the previously described opera is reversed and repeated.

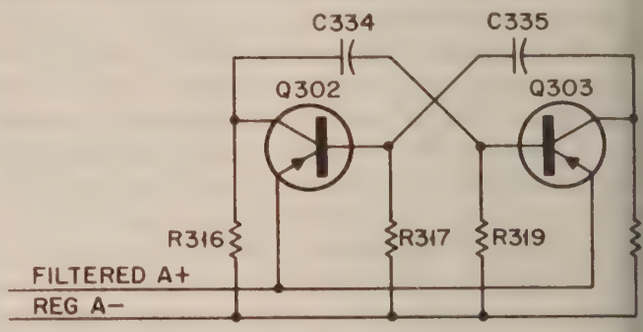


Figure 3.
Astable Multivibrator Circuit

(3) Ring Stepper

The ring stepper is a circuit that s lates a stepping switch, i.e., with each suc sive input pulse a different pole or element i ergized. Each element in this ring stepper ploys a direct coupled P-N-P--N-P-N trans pair and each pair saturates in turn with ea successive input pulse.

The following description is for the eration of a three module ring stepper. A s per with additional stages would operate sim ly.

The driver and the three direct cou channel element circuits are shown in Figu Driver transistor Q304 is normally saturate the base emitter junction is forward biased 0.3 volts. Assume that the first channel ele of the ring stepper, consisting of Q308 and is initially in the fully saturated or on condi The coupling capacitor C351 between the f and second element circuits has almost no ch on it while the other two-coupling capaci C351 are charged to about 10 volts in the pola shown.

When a positive pulse is applied to base of Q304, it is momentarily cut off and a ative pulse is generated at its collector. T negative pulse is coupled to the common emit of Q309 causing Q309 (1st module) to turn o When this occurs, the potential at the colle

09 goes negative along with the base of Q308
t module). Transistor Q308 is also turned off
C351 (1st module) now starts to charge to the
ative supply. If the negative pulse on the com-
n emitters is ended before C351 (1st module)
fully charged, the emitter of Q309 (2nd mod-
) returns to -0.7 volt while its base is held
ative by the charging of C351 (1st module).
refore, Q309 (2nd module) now starts to con-
t and a positive potential is applied to the base
308 (2nd module) driving it into conduction.
s action continues until Q308 and Q309 are
locked in saturation. When a positive pulse
gain applied to the base of Q304, a same
ence of events occurs. The result is that
second module is turned off and the third
ule is turned on. Note that when a pulse is
ied to the input, only one module can be turn-
n since the coupling capacitor between an on
off module is the only one that is charging
n the drive pulse ends. The components
es for the stepper circuit are chosen so that
one module can conduct at a given time. If
modules try to conduct, the increased drop
ss R325 drives the common emitters nega-
enough to cut off one of the modules.

The operation of the circuit is depend-
upon the drive pulses being of short dur-
. These short duration pulses are ob-
d by making the time constant of C336-R324
l. Therefore, Q304 is cut off for only a
t duration making the drive pulses approxi-
ly 10 microseconds in duration.

(4) Starting Circuit

The starting circuit (figure 4) ensures
one plug-in channel element becomes ac-
ed when operating power is applied to the
lator module socket board. It consists of
ransistor and associated circuitry. Voltages
the power supply and biasing arrangements
de the necessary conditions to turn on the
ing transistor. The positive voltage appear-
its collector, at turn on, is coupled to the
el element in board socket #1. Consequent-
annel element #1 becomes energized and,
se of this action, a positive voltage is ap-
to the junction of R332 and R341. This back
s the base-emitter junction of the starting
istor and it goes into cut-off. Therefore,
any one of the channel elements is ener-
, the starting transistor is held in cut-off.

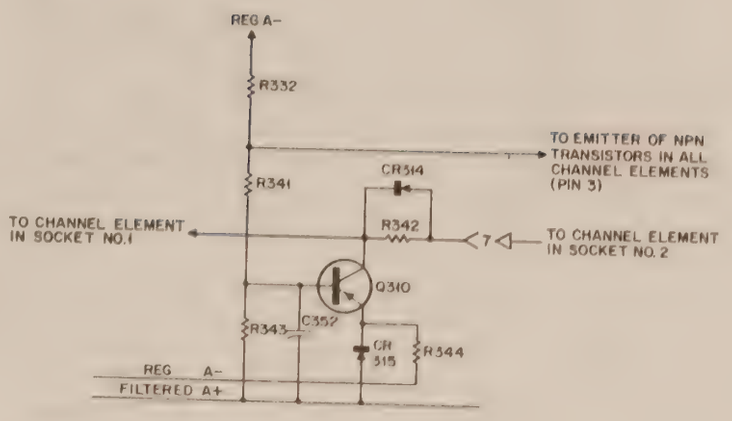


Figure 4.
Starting Circuit

(5) Oscillator

The oscillator housed in the plug-in channel element is temperature-compensated and crystal-controlled without the use of ovens or heaters. The circuit is of unique design and provides the following features:

(a) Frequency stability of ±5 ppm in the temperature range between -30° C to +70° C.

(b) A relatively constant output that is applied to a buffer-amplifier and limiter stage which provides an output to both the receiver first oscillator multiplier board and transmitter modulator.

The crystal in series with the parallel capacitor warping network is connected to the transistor base lead to control the feedback frequency. The oscillator uses the anti-resonant mode of the crystal (32 uuf load). The purpose of the variable capacitor in the parallel capacitor network is to provide a variable reactance which can be used to warp the crystal frequency above and below the anti-resonant frequency. To maintain the 5 ppm frequency stability in the temperature range between -30° C and +70° C, a temperature compensating thermistor-capacitor network is included across the parallel capacitor network. Therefore, as the oscillator frequency drifts due to temperature changes, the compensating network introduces a reactance which, in turn, increases or decreases the oscillator frequency. The oscillator is turned on when the ring stepper circuit in the same channel element becomes activated. When this occurs, the positive potential developed at the collector-base junction of the P-N-P--N-P-N transistor pair is applied to the

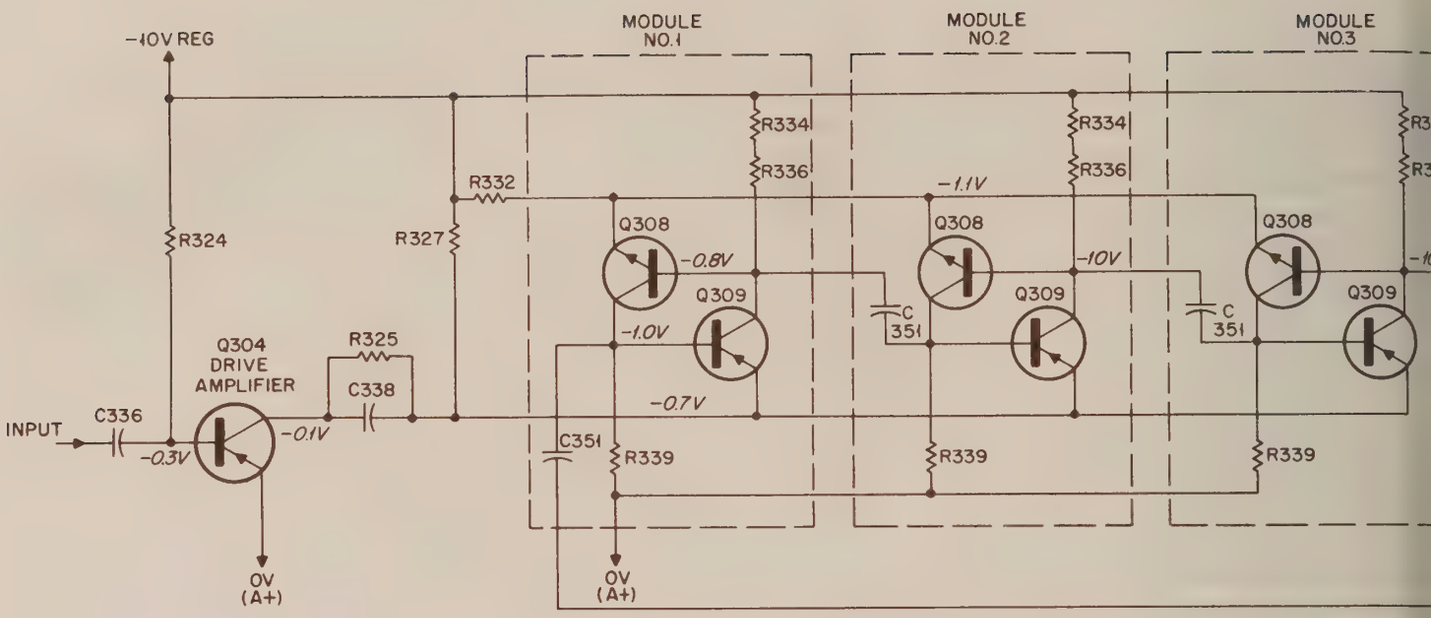


Figure 6.
Ring Stepper Circuit

emitter of the oscillator transistor. This turns on the transistor and it then begins to oscillate.

(6) Buffer-Amplifier and Limiter

The signal from the selected oscillator module is amplified (Q311) and amplitude limited (Q312) in the buffer-amplifier and limiter stages. The output of the buffer-amplifier feeds the limiter and receiver first oscillator multiplier board. The output of the limiter is injected into the transmitter modulator stage. The limiter maintains a constant output to the transmitter modulator to prevent changes in transmitter deviation due to variations in oscillator output. A diode gate is also included in the output circuit of the limiter stage.

d. Circuit Operation

Refer to Schematic Diagram 63E81022A67.

When d-c power is applied to the oscillator module socket board, regardless of mode of operation, starting transistor Q310 turns on the number one channel module. Switching from module to module is accomplished by pulses from the fast 500 cps astable multivibrator or the slow 4 cps astable multivibrator. The fast astable multivibrator is controlled by the fast astable control circuit and the slow astable multivibrator is controlled by the supervisory unit.

When a positive voltage is applied to J401-27 from the control head, it is fed through R312 to the base of Q301, driving it into conduction. When Q301 conducts, it drives the emitter of Q303 ative and prevents the fast astable multivibr from running. In this condition the slow asta is switching the channel modules or the radio is locked on the idle channel.

If the positive voltage is removed or a n ative voltage is applied to J401-27, Q301 is off driving the emitter of Q303 positive. Th turns on the fast astable multivibrator. Posi pulses are applied to the base of the drive am fier transistor Q304 through C336 and CR3 The drive amplifier generates a pulse for ea input pulse from the fast astable multivibrat The pulses are applied to pin 6 of all chan modules via R325 and C338. For each pulse channel module is turned off and the next is tu on in rapid succession.

When a negative voltage is applied to J4 from the supervisory chassis, the slow ast multivibrator is turned off. In this condition radio set is locked on the idle channel. Whe positive voltage is applied to J402-8, the sl 4 cps astable multivibrator operates and ge ates pulses which are fed from the collector Q305 through C339 and CR313 to the base of The drive amplifier in turn generates pulses applies them to the channel modules. A nega voltage on J402-23 keys the transmitter. T negative voltage is also applied to the anode CR313, the diode gate, to keep it back bias This prevents pulses from either the slow or astable multivibrator from reaching the drive plifier. Thus, channel switching is inhibited w the transmitter is on.

Switching over the channels is a function of oth the slow and fast astable multivibrators. In he home mode, jumpers in the control head des- gnate the home channels. The fast astable switches n the channels which are not jumpered and these hannels will remain on for only two milliseconds. he slow astable switches on the jumpered chan- els and the channel will remain on until the super- isory chassis commands switching to the next hannel.

If a jumpered channel is turned on, a posi- ive voltage is fed from the channel module to the ast astable control to keep the fast astable mul- ivibrator disabled. This voltage is fed via pin one of he channel module, J401-15, through the jumper n the control head selector switch, J401-27 to 312, to the base of Q301. Thus the voltage feed- ack path is complete and the fast astable multi- ibrator is inhibited. When the slow astable mul- vibrator turns on by command from the super- isory chassis, a pulse will turn on the next chan- el element.

If a non-jumpered channel is turned on, the ositive voltage feedback does not reach the fast stable control and the fast astable multivibrator perates.

Operation in the roam mode is similar to the ome mode except the positive voltage path from ie channel module to the base of Q301 is control- ed by the pushbutton switches (not jumpers as in ie home mode). The pushbutton switches that re depressed will complete the d-c path and turn ff the fast astable multivibrator.

In the manual mode of operation, the slow stable multivibrator is always inhibited by the upervisory chassis. When a channel button is elected, the d-c path to the fast astable control s complete and the fast astable multivibrator op- rates. The fast astable multivibrator will switch rom channel to channel until the selected chan- el element is turned on. At this time, the d-c ath is broken and the fast astable multivibrator s inhibited. This channel is now locked on until nother pushbutton is depressed.

2. DIPLEXER

The diplexer is a frequency selective device that makes it possible to operate the transmitter and receiver from the same antenna without adverse interaction. It consists of a transmitter leg and a receiver leg containing high Q resonators.

The transmitter leg contains two series tuned traps Z2 and Z3, and a combination series resonant and anti-resonant circuit composed of Z4 and L11. Z2 is tuned to the receiver image frequency which is 10.52 mc above the receiver frequency of approximately 152 mc. Z3 is tuned to the receiver frequency. Z4 is tuned to the transmitter frequency which is 5.26 mc above the receiver frequency. L11 is chosen to parallel resonate with Z4 at the receiver frequency. The primary purpose of this circuit is to provide attenuation at the receiver frequency toward the transmitter, at the same time prevent the loading of the receiver by the transmitter leg.

The receiver leg consists of a combination series resonant and anti-resonant circuit composed of Z5 and C385. Z5 is tuned to series resonance at the receiver frequency and C385 is chosen to be anti-resonant at the transmitter frequency. This prevents the loading of the transmitter circuit by this leg and also keeps the transmitter energy out of the receiver.

3. RECEIVER

The receiver is a completely transistorized double-conversion superheterodyne type. It accepts FM signals on any of eleven fixed, crystal-controlled frequencies in the 152-162 mc band. The receiver block diagram (Figure 7) shows the stage by stage signal flow and operating frequencies.

a. RF Preselector and RF Amplifier

The r-f section of the receiver contains an r-f preselector and common emitter r-f amplifier stage.

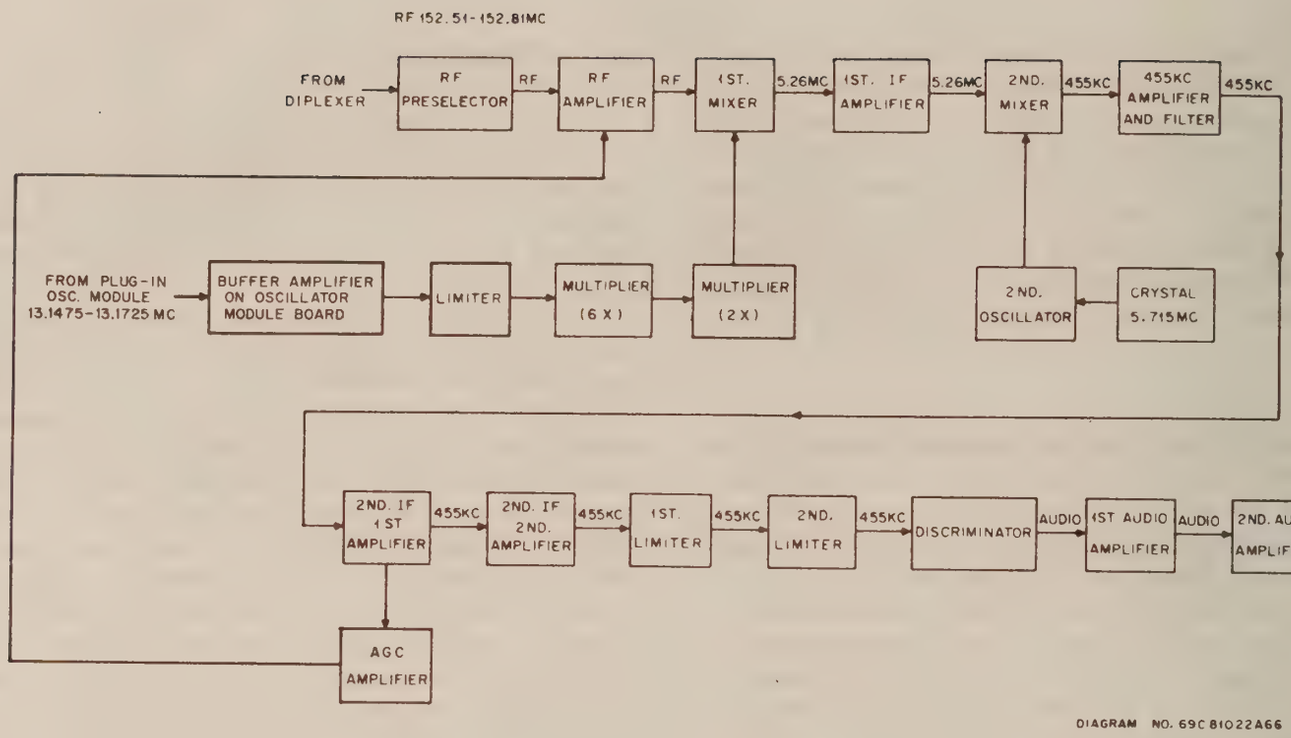


Figure 7.
Receiver Block Diagram

The r-f preselector consists of five low loss, highly selective helical resonant cavities. The preselector bandpass frequency response has a flat acceptance bandwidth and a steep skirt to provide rapid attenuation of signals outside the acceptance bandwidth.

The carrier signals received at the antenna are coupled through the diplexer and then through the preselector cavities to the base of the r-f amplifier. The gain of this stage provides an optimum signal-to-noise ratio in the signals sent to the first mixer.

b. Multiplier

The output of the oscillator module board is coupled to the transistorized multiplier and audio board. The multiplier circuit consists of a limiter, and two stages of multiplication. Its output is twelve times the oscillator input frequency.

c. First Mixer

The first mixer heterodynes the signal from the r-f amplifier with the signal from the multiplier board to produce the first intermediate frequency (1st i-f) of 5.26 mc.

These frequency relationships can be expressed as follows:

$$12f_1 - f_c = 5.26 \text{ mc}$$

mult. factor — 1st freq. — r-f carrier input = 1st o (1

$$f_1 = \frac{f_c + 5.26 \text{ mc}}{12}$$

Note that the injection frequency is 5. above the carrier frequency.

The first mixer is a low noise transis and produces a power gain.

d. First IF and Second Mixer

The first i-f consists of a common em amplifier stage and five tuned circuits. Th quency of the first i-f is 5.26 mc. The ou of the first mixer is coupled to the base of 5.26 mc amplifier through two selective do tuned circuits.

The output of the 5.26 mc amplifier is c to the base of the second mixer through thr highly selective tuned circuits. Also appli

o the base of the second mixer is the injection requency of the second oscillator. The second scillator frequency is controlled by a 5.715 mc rystal. The frequency of the second oscillator nd the 5.26 mc frequency of the first i-f is naintained constant for all incoming signals at he antenna. The difference between the second scillator frequency and the first i-f frequency s the second mixer output. This output is a 455 c signal. The frequency relationship of these hree stages is as follows:

2nd local osc. freq.	5715 kc
1st i-f	5260 kc
Difference freq. (2nd i-f)	455 kc

AGC Circuit

The AGC circuit consists of a common emit- r NPN amplifier stage and a voltage doubler rcuit. It automatically adjusts the gain of the -f amplifier by controlling the current which an be drawn by the r-f stage. With no signal pplied to the circuit, the AGC stage is biased to saturation (fully conducting).

The output of the 1st 455 kc i-f amplifier is oupled to the base of the AGC stage through a oltage doubler circuit consisting of two diodes nd two capacitors. The negative output from is circuit drives the AGC stage toward cut-off. onsequently, the current through the AGC stage the collector of the r-f amplifier is reduced. hus, for medium and weak signals, the current the collector of the r-f amplifier is greater an for strong signals. In this manner, the gain the r-f amplifier is automatically controlled er a specific range of input signals.

Second IF

A "Permakay" i-f filter containing a tran- stor amplifier stage is used in the second i-f. e filter sections are permanently sealed in lyesterstyrene and the filter is unconditionally aranteed for the life of the receiver, provided e seal is not broken and the housing is not tam- red with. The amplifier circuitry is mounted an eyelet board within the filter and is acces- ble for servicing. This filter is the major tor in determining the bandwidth and selecti- y of the receiver. It greatly attenuates the nal outside the pre-determined bandpass. o i-f amplifier stages follow the 455 kc filter saturate the limiter.

Limiter Stages

The two limiter stages are 455 kc amplifiers arranged so that an increase in input signal produces no change in the amplitude of the output signal. Operation of the limiters depend upon the application of a large amplitude signal. With weak or strong signals applied to the input of the receiver or with noise only, the limiters are in full saturation at all times. That is, the output of the limiters is a signal of constant amplitude. With weak signals or noise only, limiting occurs in the collector circuit of the first limiter stage. Specifically, the collector voltage swings from its maximum to its minimum value as established by the bias on the transistor. This voltage swing is the base drive for the second limiter stage. Because this signal is of large amplitude, it drives the second limiter from full saturation into full cut-off.

h. Discriminator

The discriminator used is a phase discriminator, that is, the operation is dependent upon a 90° phase shift which occurs at resonance between the primary and secondary voltages of the tuned transformer.

The discriminator recovers the audio from the 455 kc i-f signal. A typical discriminator response curve is shown in Figure 8.

The i-f signal varies in frequency at the audio rate. This is shown below the curve. The corresponding audio output is drawn to the right of the curve. The 455 kc board operates with a

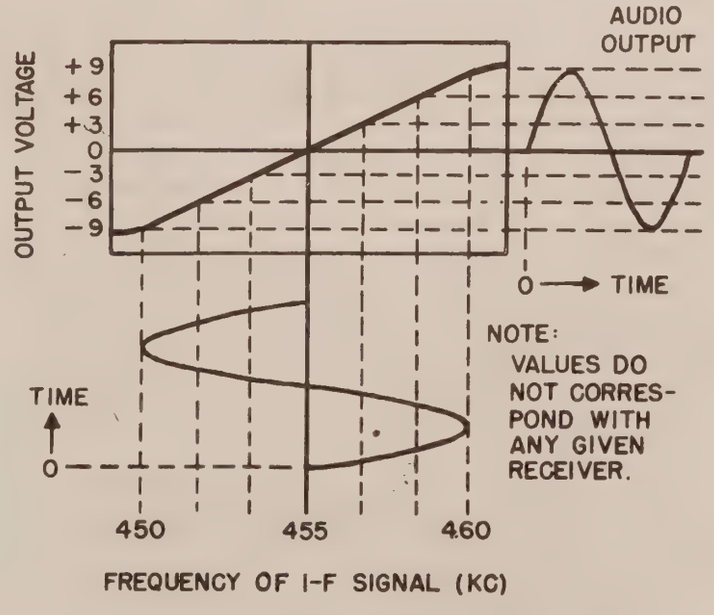


Figure 8.
Typical Discriminator Response

-10 v d-c regulated supply to maintain a constant audio output with changes in battery voltage.

i. Audio Circuit

Audio signals from the discriminator are coupled through an interstage level setting network to the first audio stage. The level setting network is factory adjusted and fixes the signal level applied to the base of the first audio amplifier stage.

Capacitor C89 at the base of the first audio amplifier provides the 6 db per octave de-emphasis. The audio signals are then amplified and passed to an emitter-follower power output stage which is also used for impedance matching. A d-c feedback path is provided from the output stage to the base of the first audio amplifier by R368, R68, and C386. This network stabilizes the operating point of the audio stages over a wide temperature range.

4. TRANSMITTER

The transmitter is phase-modulated and operates on any of eleven crystal-controlled frequencies within the 152-162 mc band. The power output is 20 watts. The transmitter consists of a transistorized audio-exciter board and three vacuum tube stages. The fundamental crystal frequency is multiplied 12 times to provide the final r-f amplifier output frequency.

Figure 9 shows the stage-by-stage signal flow and operating frequencies.

a. Microphone Circuit

A push-to-talk telephone handset is used this transmitter. The handset is wired into control head. The microphone element connec tween the center conductor and the shielded lea the audio input cable. A d-c voltage on the sh ed lead provides bias current for the carbon crophone.

b. Audio and IDC ("Instantaneous Deviation Control")

The audio signal from the microphone coupled to the base of an audio amplifier s through a sensitivity selection network. A jur lead and a resistive network with four connec terminals is used for setting the desired au sensitivity. The four sensitivity settings ra from low (LO) to high (HI) in 3 db steps. To from the supervisory unit are applied directl the base of the audio amplifier. The audio am fier output is applied to a deviation limiting cuit. Since the wavefront slope depends upon the amplitude and frequency of the incoming nals the overall effect of the deviation limitin cuit is to place a barrier upon the maximum front slope which can pass into the modulator

The deviation limiting circuit consists c components for pre-emphasizing with a 6 db octave characteristic, amplifying, limiting, then de-emphasizing. The limiter stage cli both positive and negative peaks when they ex a pre-determined clipping level. The audio

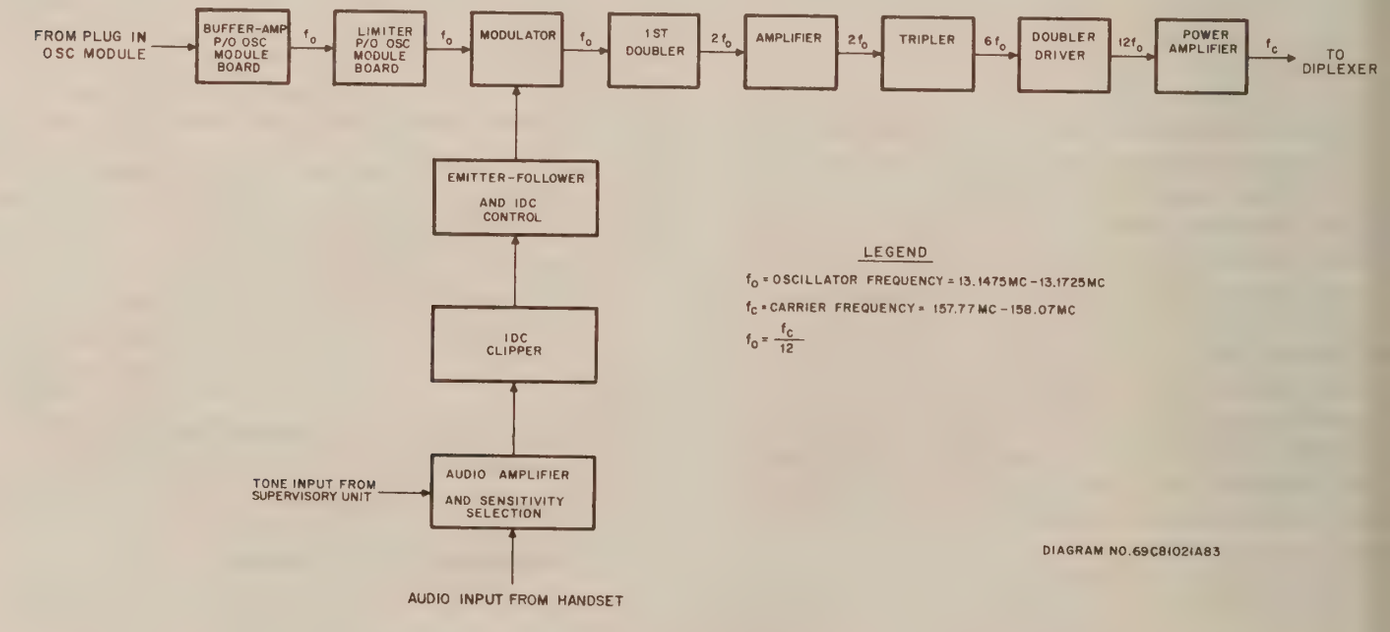


Figure 9.
Transmitter Block Diagram

asses through a low pass filter to an emitter-llower stage and IDC control ("Instantaneous eviation Control"). The filter attenuates the fre-uencies above 3 kc to limit the transmitter mo-ulation spectrum to the required bandwidth. The nitter-follower stage matches the output imped-nce of the deviation limiting circuit to the mo-ulator stage. The IDC control adjusts the audio vel applied to the modulator stage and is used set and limit transmitter deviation to ±5 kc.

Modulator

The activated oscillator and audio-IDC out-uts are applied to the phase modulator, so that eviation varies with frequency and amplitude of e modulating signal.

Multipliers and PA

The modulator output is applied to the dou-er where the signals are amplified and doubled frequency. They are further amplified in an nplifier stage, tripled in frequency in the tri-er and then doubled once more in the doubler-river. The doubler-driver stage develops the equired signal power to drive the power amp-fier to its rated r-f power output. The signals eaching the final amplifier have been multiplied 2 times from the original frequency generated y the oscillator in the energized plug-in chan-el element. The output of the power amplifier coupled to a harmonic filter, then to a diplex-r and finally to the mobile antenna. The har-onic filter is a bandpass filter specifically de-gned to attenuate spurious emissions of the ansmitter.

Exciter Shut-Off Circuit

Unwanted radiation is limited by shutting off e exciter supply during standby operation. The citer is disabled in standby by back-biasing 08. When the transmitter is keyed, B+ forward ases the base-emitter junction of Q208. Q208 en saturates and the exciter board supply is en-gized.

POWER SUPPLY

The power supply serves the following func-ons:

Converts the low voltage d-c battery input the high voltage d-c (300 volts) required for eration of the transmitter.

Limits the current drawn by the transmitter ament circuit for controlled heater warmup urge protection).

Furnishes a regulated -10 v d-c output.

d. Limits the battery voltage applied to the transmitter filaments for over voltage regulation.

The power supply converts the low voltage d-c input to the high voltage d-c required for operation of the transmitter as follows:

First Activating a transistor network which applies battery A+ to the transistor switching circuitry-----turn-on circuit.

Second Changing d-c to a-c-----transistor switching circuit.

Third Stepping up the a-c voltage-----power transformer.

Fourth Converting the high voltage a-c into d-c-----rectifier and filter networks.

NOTE

The power supply will operate from a positive or negative ground 12 v d-c source. Refer to the installation instructions supplied with the radio set for proper installation of the appropriate polarity determining cable kit.

(1) Turn-On Circuit

The turn-on circuit is essentially a transistor switch. It is comprised of two transistors, main switch (Q201) and driver (Q202), with associated components. When activated, the turn-on circuit applies battery A+ to the transistor switching circuitry. The base and emitters of both transistors (Q201, Q202) are connected directly to A+. A- is applied to the turn-on circuit through the push-to-talk switch contacts on the handset. Therefore, when the push-to-talk button on the handset is pressed, both A+ and A- are applied to the turn-on circuit and the driver transistor begins to conduct. The main switch is then quickly driven into saturation and the power supply begins to operate. A diode is also included in the circuit for transistor protection. It conducts and causes a fuse to blow should the power supply be connected to a power source of wrong polarity.

(2) Transistor Switching Circuit

When the turn-on circuit is activated, A+ is applied to the emitters of two power transistors (Q203, Q204) which are part of an oscillator switching circuit. The input voltage is across each transistor and its associated half of

the transformer winding to A-. The base of each transistor is connected to the transformer feedback winding. One transistor conducts more heavily than the other when the input voltage is first applied. The polarity of the voltage induced in the feedback winding is such that the transistor which begins to conduct more heavily than the other is quickly driven into saturation. The other transistor is quickly cut off. Current flows through the conducting transistor and its associated half of the transformer primary winding until the transformer core is saturated, at which time the voltage induced in the feedback winding reverses in polarity. The cut-off transistor is quickly driven to conduction through its associated half of the transformer primary winding; the first conducting transistor is quickly driven to cut-off. Conduction continues until the transformer core is again saturated. Then the cycle is reversed and repeated. This causes current to flow alternately in opposite directions through the two half-windings of the primary. The circuit provides continuous, self-sustaining oscillation as long as the d-c input is applied. The switching action is very rapid (1500 cps) and the induced voltages approximate an ideal "square wave".

The secondary windings of the transformer provide the various voltages required for operation of the transmitter.

(3) Functions of Components

(a) Starting Circuit

The starting circuit consists of a resistor and a capacitor. A large amount of forward bias is applied to both power transistors (Q203, Q204) as a result of the capacitor charging current which flows when A+ is applied. This forward bias starts transistor conduction. Since there is never equal conduction in transistors, one transistor conducts more than the other. The heavier conducting transistor is driven into saturation and the other transistor is quickly driven to cut-off.

(b) Feedback Circuit

The feedback circuit consists of a transformer feedback winding, a resistor, and the base emitter junction of the power transistors. When A+ is applied, the starting circuit capacitor charges through the transformer feedback winding and the emitter-base junction of the power transistors. When the capacitor becomes fully charged, forward bias for the pow transistors is no longer developed. However feedback bias, by virtue of transformer action is now sufficient to sustain oscillation and the power supply becomes activated. If a B+ sho circuit should occur, the feedback bias to the power transistors is reduced to a point where the circuit stops oscillating. The power suppl then becomes de-activated and remains in tha condition until the short circuit is removed.

The resistor in the feedback network determines the amount of drive current f back to the bases of the transistors. It also affects the maximum power which can be draw from the secondaries of the transformer.

(4) Transmitter Section

The transmitter B+ rectifier-filter ne work converts the high-voltage a-c induced in t transformer secondary to the ripple free d-c o put required for the transmitter. The networ consists of one full-wave bridge rectifier and filtering circuits.

Transmitter B+ is supplied from the output of the filtering network. The high-voltag a-c is connected to opposite corners of the brid circuit. The filter network smooths out the vol age ripple. The output of this section is routed directly to the transmitter.

The transmitter bias network includes a low-voltage secondary of the transformer, a rectifier and a filter network. The negative bia voltage is applied to the transmitter power amplifier grid circuits.

Microphone voltage is taken from a -1(volt regulated line.

(5) Controlled Heater Warm-Up

Controlled heater warm-up is accomplished by a Schmitt trigger circuit which consis of an input stage transistor (Q205), an output stag transistor (Q206) and associated components. I is used to control the current drawn by the trans mitter tube filaments during a pre-determined warm-up period. The transmitter tube filament are connected into the common emitter circuit o the Schmitt trigger to be used as the emitter re sistor.

Initially at turn-on, the output stage tran sistor is cut-off and the input stage transistor

ns to conduct. This condition is assured by pacitor (C208) which causes a momentary ging current to flow when the operating power pplied. With the output stage cut-off, fila- t current is routed through a resistor (R212) h is connected across the collector and emit- of the output stage transistor. This resistor ts the current that can be drawn by the trans- er tube filaments from a cold start. When esistance of the tube filaments approaches quals the resistance of the aforementioned stor, biasing arrangements are such that the t stage transistor is turned off and the out- tage transistor is brought into conduction. n the output stage transistor is turned on, ow saturation resistance effectively short uits R212 and full filament voltage is applied e transmitter tube filaments.

(6) -10 V DC Regulated Output

The -10 volt d-c regulated output for o set operation is provided by an emitter- wer transistor stage (Q207) and Zener diode 04. The base of the emitter-follower is con- ed to the junction of resistor R213 and diode 10. The anode of the diode is tied to the ter of the Schmitt Trigger output stage used ontrolled heater warm-up. While the out- tage is turned off, an alternate d-c path is ided through CR210 and R213 and the bias e base of the emitter-follower is reduced. lack of base drive causes a reduced nega- output at the emitter of Q207 and radio set ation is inhibited. When the transmitter tube filaments have partially warmed up and the Schmitt Trigger output stage is turned on, the negative potential at the base of the output stage transistor appears at its emitter. Diode CR210 becomes reverse biased and the alternate d-c path is no longer provided. Consequently, the base drive to the emitter-follower increases and becomes regulated to -10 v d-c by the Zener diode. This regulated voltage then appears at the emitter of Q207 from where it is routed to the base of the output stage transistor and to the -10 v d-c regulated line.

(7) Over Voltage Regulation

Over voltage regulation is provided to ensure that the battery voltage applied to the transmitter tube filaments circuit does not exceed the rated value of the filaments during high battery voltage conditions. This feature is accomplished as follows:

The output stage transistor (Q206), employed in the Schmitt trigger circuit and used for controlled heater warm-up, derives its base potential from the junction of two resistors (R210, R211). One resistor is tied to A- and the other is connected to the -10 v d-c regulated line. This voltage divider network is so designed that in high battery voltage conditions the base potential of the output stage transistor never exceeds the rated transmitter tube filament voltage. When the transmitter tube filaments have partially warmed up and the transistor is turned on, its base potential appears at the emitter from where it is applied to the filament circuit.

SERVICE AIDS

PRINTED CIRCUIT REPAIR TECHNIQUES

Printed wiring is rapidly assuming the ma- ole of the various wiring methods used in ronic equipment, and you, the service tech- n, will be coming into more frequent con- with this new method of wiring.

Among the advantages of using printed wir- re uniformity of assembly, elimination of g errors, and almost complete elimination re and component dressing problems in cri- circuits. Not the least of the advantages is of servicing, once a few service techniques e to printed circuits have been mastered.

Basically, a printed circuit is a metal foil plated onto a laminated plastic board which has been die-punched to shape and drilled to provide the necessary mounting and connection holes. The metal foil replaces the conventional wire leads. Since all the boards for a particular radio unit are made from the same pattern, the wiring is uniform and free from error. Usually components are mounted through holes in the board which means they are held securely in place.

In the past, servicemen have been led to believe that printed circuits are extremely fragile and that an exceptionally low wattage soldering iron must be used to prevent the heat from lifting the plating. This is a misconception. Ex-

perience has shown that using a soldering iron with low heat output, in many cases, has actually caused the damage that the servicemen was trying to prevent. It is absolutely necessary to raise the temperature of the connection until the solder flows freely around the board eyelet. This usually takes a considerable length of time with a very low heat iron. During this time heat is conducted away from the connection by the printed wiring causing them, in some instances, to break away from the board. If a component is to be removed, its soldered connections must be raised to a temperature that permits free flow of solder. Otherwise the component's leads may not be freed from the printed wiring and the wiring will be pulled loose from the board as the component is removed. The No. 776 soldering iron (47.5 watts, 850°F heating element) supplied with the Motorola Printed Circuit Repair Kit is recommended for most work on printed circuit boards. This hi-heat iron need be applied only a very short time to heat a connection to the point where solder flows freely. It is obvious that an iron this hot should not be held on a connection longer than necessary. Extended periods of high heat will cause the foil to peel loose from the board.

The tip of the iron has a tapered point to permit its exact application to the desired connection in compact equipment. Always keep the iron tip well tinned and clean.

Breaks in the printed wiring can be repaired by bridging the gap with solder. Remove the resin coating covering the printed wiring with solvent before soldering. Large areas of the printed wiring that have peeled loose can be repaired with a piece of hook-up wire. The hook-up wire should follow along the path of the original printed wiring. This avoids any lead dressing problem in critical circuits.

When removing resistors, capacitors and similar components, heat the connection to be loosened until the solder is molten. Then brush away or shake off as much of the molten solder as possible. If the leads are bent over use a soldering aid tool or a knife to straighten them. It may be necessary to apply the soldering iron while doing this. While applying the soldering iron wiggle the component lightly to free it. Then lift it from the board. Be sure the component leads are free before trying to remove it or you might pull loose some of the printed circuit wiring. Clean the circuit wiring around the holes with solvent. Install the new component and solder it in place. Coat the cleaned area of the circuit board with silicon resin. Such a coating seals the board from excessive moisture, prevents corrosion of the copper pattern, helps maintain insulation resistance and improves the appearance of the work. Never let solder flux bridge the gaps between the wiring pattern. This can reduce the resistance between circuits to only a few megohms which will cause leakage and disrupt certain electronic circuits. Use solvents to clean away flux after soldering. Defective components can also be replaced by clipping the leads as close to the component as possible. Solder the replacement component to these leads. Caution should be used when applying heat so that the original leads don't fall out of the board. This method of component replacement should not be used if the equipment is subjected to severe vibration.

Complete removal of the printed circuit boards for access to components is not always necessary. Most components are accessible as mounted. The following steps outline procedures to prepare various parts of the radio set for servicing. Observe standard servicing practice such as tagging of leads and identification of connecting points.

NOTE

The letters and numbers that appear in the boxes near the photographs, indicate corresponding steps in the following paragraphs. Example: 2. a. (1)(b) in Figure 11. indicates the location of items discussed in paragraph 2, subparagraph a. (1)(b).

1. RADIO SET HOUSING REMOVAL

a. Unlock the radio set by turning the key counterclockwise 1/4 turn.

b. Position the hands with the thumbs placed on the ridge of the raised section of the top cover and the fingers against the rear edge of the front panel. Refer to Figure 10.

c. Applying pressure at the thumbs and fingers force the radio set out from the housing (about 1-1/4").

d. Grasp and then remove the top cover by sliding it forward (about 3/8") and with the same motion lifting it up and out.

e. Remove the drawer assembly by lifting it straight up from the housing.

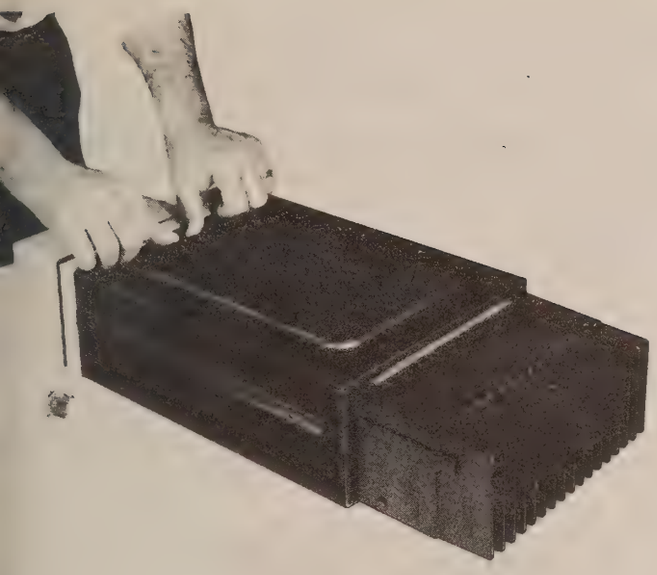


Figure 10.

TRANSMITTER

Tripler, Doubler-Driver and Power Amplifier Tubes (Figure 11)

(1) Tripler and Doubler-Driver

(a) Perform steps 1.a. through 1.e.

(b) Loosen the four retaining screws located underneath the lid on the rear heat sink housing.

(c) Gently remove the heat sink by lifting it up and away from the radio set.

(d) Remove the tubes.

(2) Power Amplifier (Figure 11)

(a) Perform steps 2.a.(1)(a) - (c).

(b) Loosen the plate contact screws and remove the contacts from the tube pins.

(c) Depress hold down clip and remove tube from socket with heat dissipating shield intact.

(3) Power Amplifier Tube Insertion

(a) Adjust heat dissipating shield so that its seam is aligned with the cathode pin on the tube base.

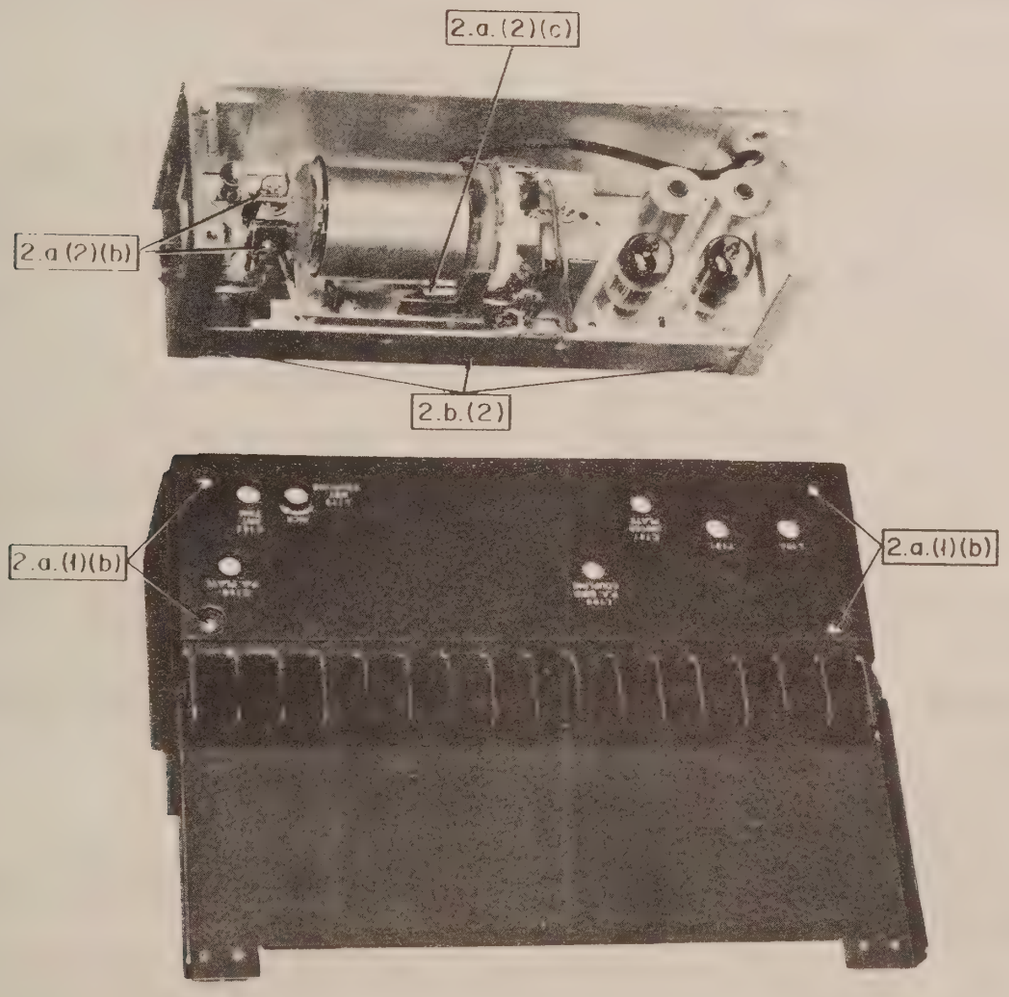


Figure 11.

(b) Position the heat dissipating shield so that the shield springs clear the tube support.

(c) Insert the tube into the socket.

(d) Replace and secure the plate contacts to the tube pins.

b. Access to Bottom of Power Amplifier Deck (Figures 11, 13, 14)

(1) Perform steps 2. a. (1)(a) - (c).

(2) Remove the three screws from the rear flange of the power amplifier deck.

(3) Remove the three screws from the bottom cover of the power amplifier deck.

(4) Remove the bottom cover.

c. Audio Sensitivity Adjustment (Audio-Exciter Printed Circuit Board) (EPD-9978)

(1) Perform steps 1. a. through 1. e.

(2) Using a long nose pliers or screwdriver, pry the jumper lead connecting pin up and away from the connecting terminal. Refer to Figure 12.

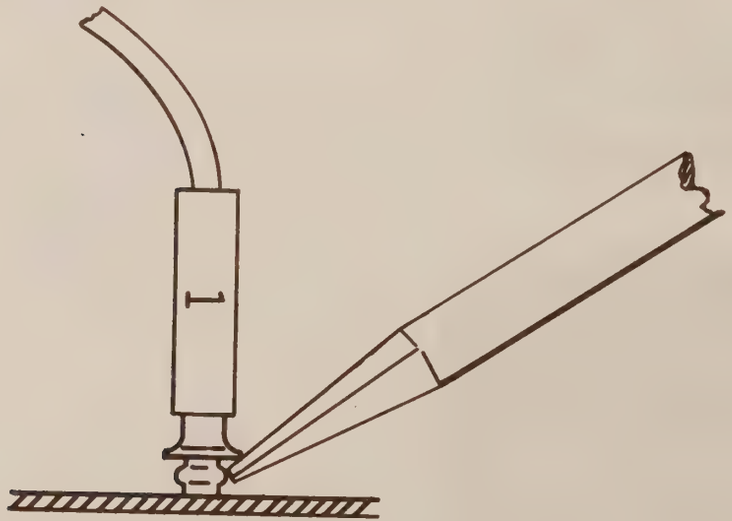


Figure 12.

(3) Connect the jumper lead to the desired connecting terminals as determined by the amount of audio sensitivity required. Audio sensitivity is reduced in 3 db steps from the high to the low position.

3. RECEIVER

a. RF Assembly Transistor Removal (Figure 13)

(1) Perform steps 1. a. through 1. e.

(2) Remove the two 2-56 screws holding the cover plate to the underside of the r-f assembly.

(3) Remove the cover plate.

(4) Unsolder the capacitor lead connected to the metal strap leading to r-f cavity L5.

(5) Unsolder the transistor collector lead from coil terminal #1 on L6.

(6) Unscrew and remove the 4-40 screw from the top of the r-f assembly.

(7) Unsolder the metal tab holding the mounting plate to the side of the r-f assembly housing.

(8) Remove the mounting plate from the r-f assembly.

(9) Remove the transistor from the mounting plate.

4. POWER SUPPLY

a. Access to Power Supply Component Boards (Figures 14, 15)

(1) Perform steps 1. a. through 1. e.

(2) Remove the four #10 screws holding the power supply housing to the radio set from the rear of the front panel.

(3) Elevate the front of the radio set so the the power supply housing can be pulled away and layed face down to expose the components contained within.

(4) Insert an elevating block under the radio set to maintain this position.

(5) Remove the two screws from each component board.

(6) Remove the boards.

b. Power Supply Transistor Removal (Q203, Q204) (Figures 15, 16)

(1) Remove the two screws from the right front cover of the power supply housing.

(2) Perform steps 4. a. (1) through 4. a. (4). Remove the two screws from the component board located behind Q203, Q204, and move the component board to gain access to transistor termina

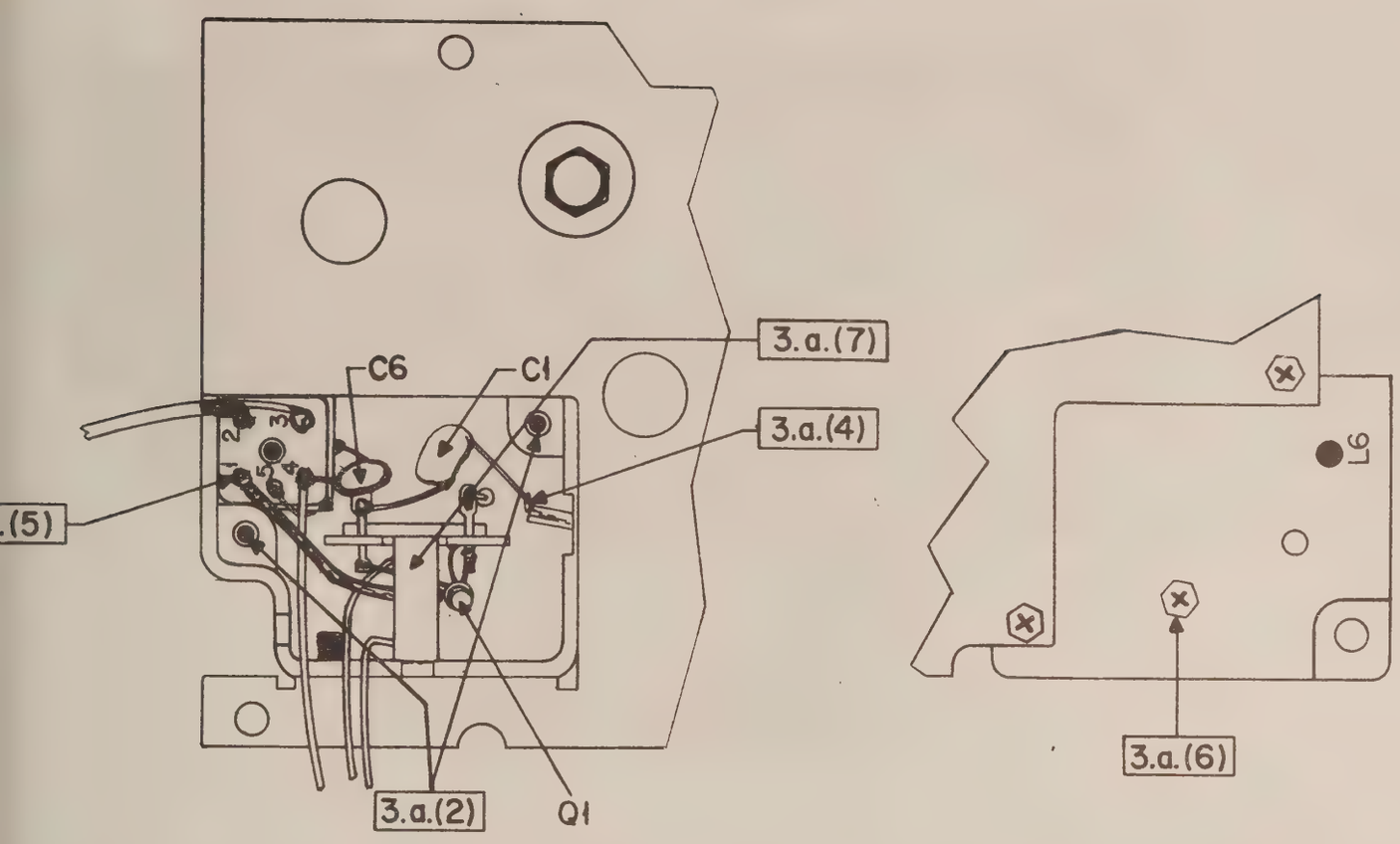


Figure 13

3) Unsolder the leads connected to the tran-
r terminals.

4) Remove the mounting nut from the tran-
r stud screw.

5) Remove the transistor from the front
power supply housing.

Power Supply Transistor Removal (Q201)
Figure 16)

1) Remove the two screws from the right
cover of the power supply housing.

2) Remove the two screws holding the
istor to the chassis.

3) Remove the transistor from its soc-

Power Supply Transistor Removal (Q202,
Q206, Q207) (Figure 16)

1) Remove the two screws from the left
cover of the power supply housing.

2) Remove the two screws holding the tran-
r to the chassis.

(3) Remove the transistor from its socket.

NOTE

When transistor replacement becomes necessary, make certain that a thin film of silicon grease is applied between the mica washer and the transistor and between the mica washer and the chassis. The grease aids in conducting the heat from the transistor to the chassis heat sink.

5. SERVICING THE CAR TELEPHONE

a. Introduction

Transistorized units have greatly increased the reliability of radio equipment. However, if trouble should develop, the same basic philosophy of service applies. Certain routine tests should be performed to determine the extent and locations of the trouble so that corrective action may be taken.

This is most easily done by tracing the trouble to a specific section of the unit by general overall checks. Once the particular section has

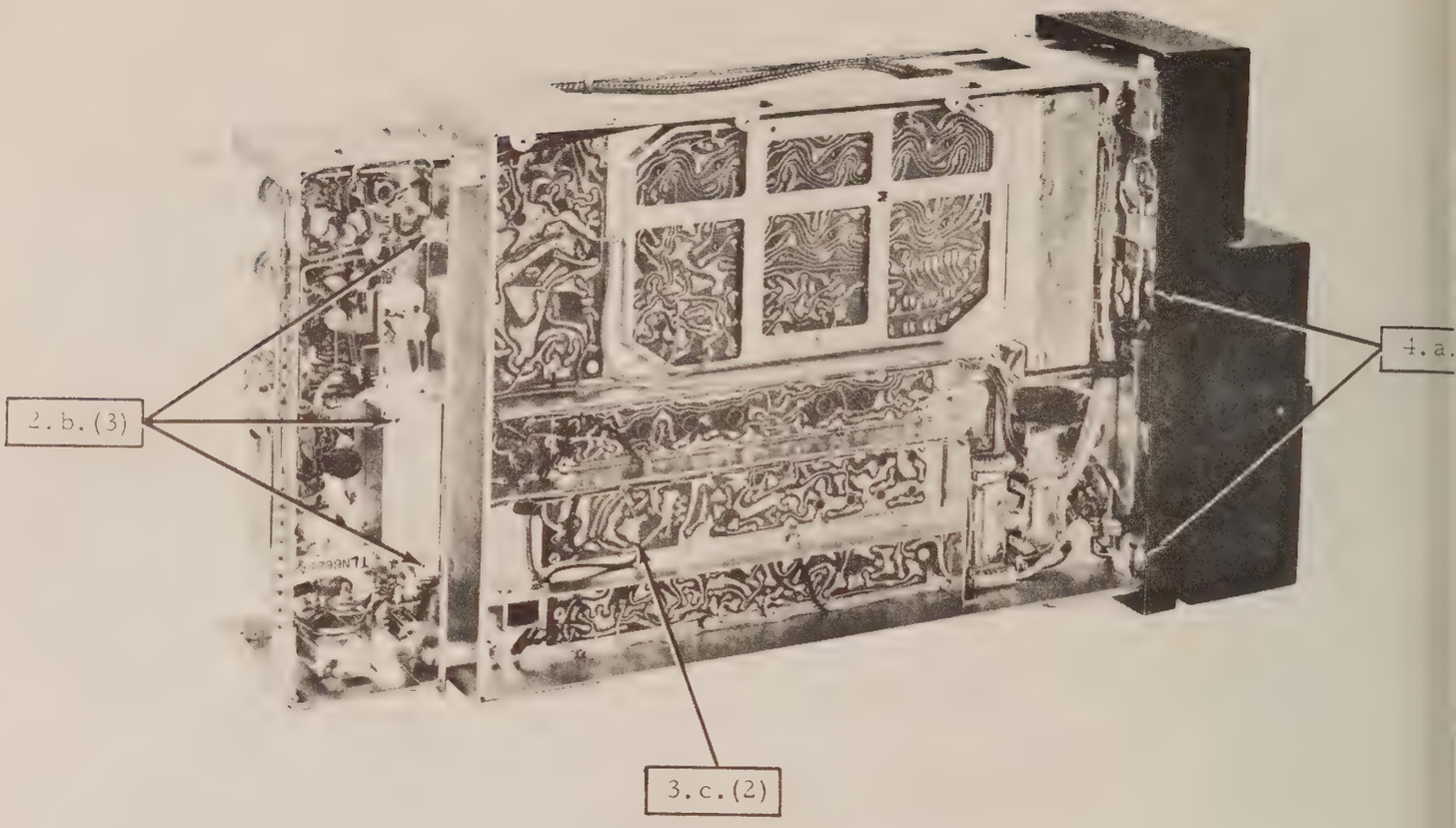


Figure 14

been isolated, more detailed tests should be made to determine the actual stage causing the trouble. When the faulty stage has been located, a thorough and complete analysis can be made to determine the precise problem.

The best means of determining the defective stage is the use of the time proven method of stage gain measurements.

Once the defective stage is isolated, a careful check of the voltages and resistances should be made to determine the defective component. In making the stage by stage, voltage and resistance measurements, it will be necessary to refer to the pictorial schematic to determine the test points required.

Due to the modular type of construction employed, there are two approaches that can be used for the actual repair once the faulty stage is found. The individual defective parts can be replaced in the normal manner, or whole sections can be substituted in a matter of minutes by replacing a complete circuit board. Thus, we have a more versatile approach to maintenance and repair than was heretofore possible with other type equipment.

Stage gain measurements are especially useful in working with transistorized equipment. This is true, because the inherent long life and reliability of transistors make the actual failure o transistor, in normal operation, a rather rem possibility. Reliability of this type means that simple procedure of replacing or substituting good transistor into the circuit would tell littl anything as to the source of trouble. This i sharp contrast to tube type equipment, where t substitution will often correct the problem, be cause the tube itself is frequently the source trouble.

The increased usefulness of stage gain me surements in transistorized equipment has led a streamlined procedure for making these chec

b. Transmitter & Receiver

In servicing the transmitter and receiver systematic check will readily localize the troub The defective stage can be determined easily b using the test set to check the readings for eac position against the readings given in this man in the alignment procedures. By starting in th proper position and proceeding to each successi stage a lower meter reading than called for in manual will indicate the defective stage. The d fective component may then be isolated by resi tance and voltage measurements. Once a defe tive component has been found by this means, can be replaced without even removing the circu board.

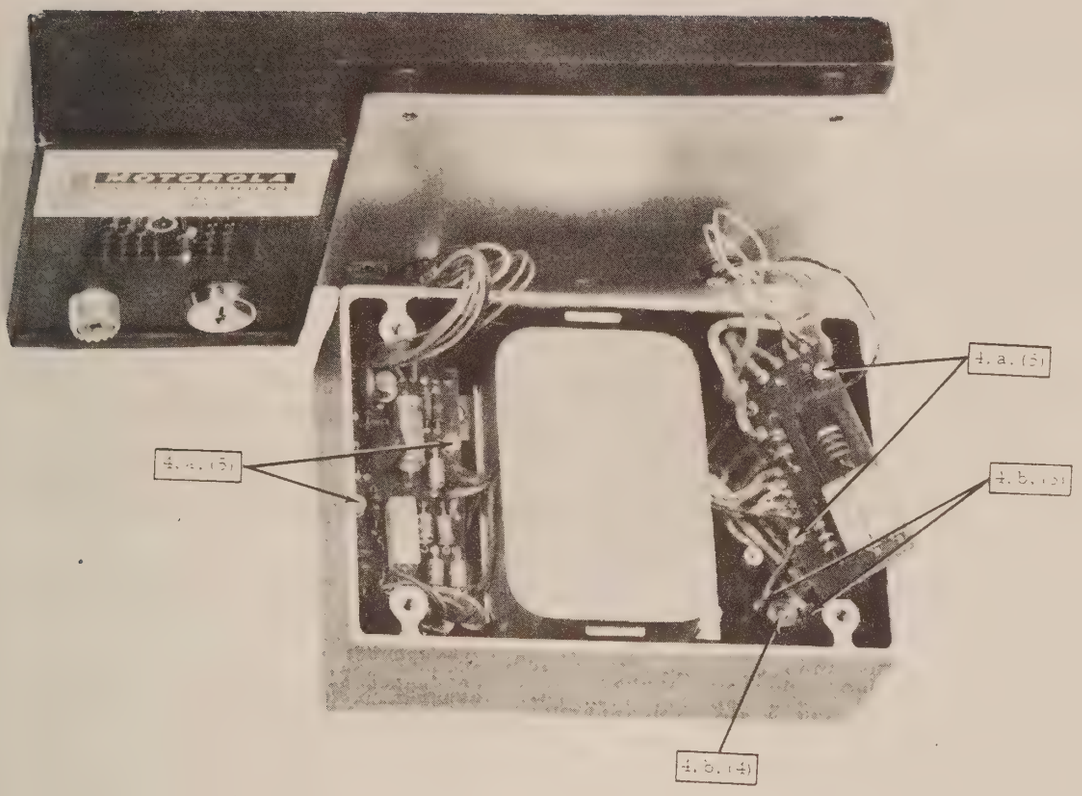


Figure 15.

AEPD-9843-O(CE2286-Y8)

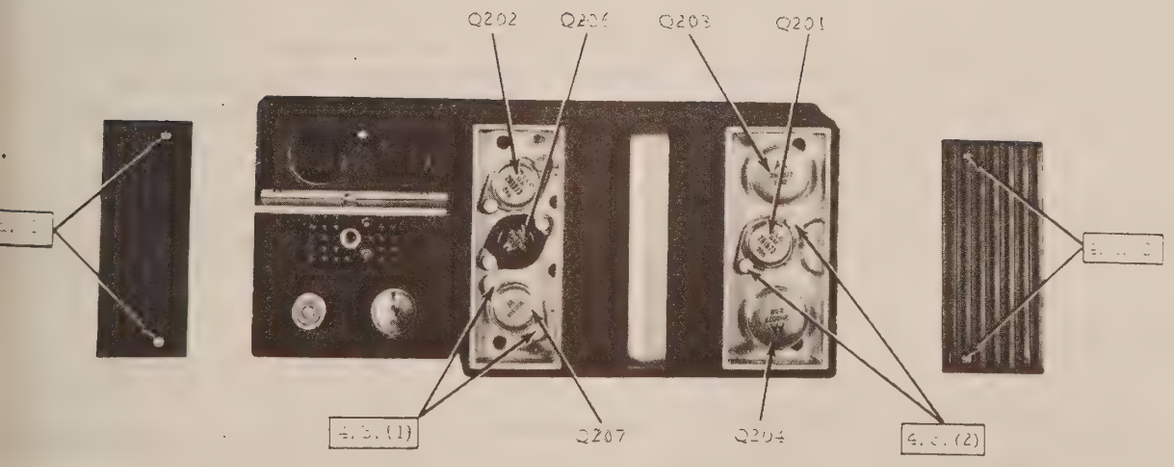


Figure 16.

AEPD-9844-O(CE2286-Y7)

c. Power Supply

The power supply may be serviced by checking the voltages against those given on the schematic. In the standby (receive) condition only the 12-volt supply to the various units in the radio set is present. There are no higher voltages. Another point to remember in servicing transistorized power supplies is that a high current short in the transmitter can load the power supply so heavily that the transistor switching circuit will drop out of oscillation. This makes it appear that the power supply is defective when the transmitter is the cause. Therefore, in the case of an inoperative power supply, once the fuses and plugs have been checked the B+ and bias load should be disconnected in order to determine whether the fault is in the power supply or the load.

If the voltages are low, check the filter capacitors for shorts and the transformer silicon diode rectifiers and associated wiring for opens or shorts. The feedback resistors should also be checked for proper value. If this does not isolate the trouble, the secondary leads may be disconnected one at a time starting with the highest voltage winding. As each lead is disconnected, check for proper operation of the rest of the power supply.

If it is found necessary to replace the transistors, refer to the Service Aids for complete information.

d. Oscillator Module Socket Board

The digital selector and oscillator module socket board may be serviced following the procedures outlined in the following paragraphs. Aside from the difference in voltage and resistan measurements, the techniques and repair proc dures described earlier apply equally well to th section of the radio set.

Use the following servicing information if improper operation of the switching circuitry i encountered.

(1) Test Equipment Required

A Motorola Model T1014B Precision Wideband Oscilloscope, or equivalent.

A Motorola DC Multimeter, or equivale

(2) Servicing

The procedures given on the following pa will help isolate any trouble to the malfunctioni circuit. Once the faulty circuit is isolated, con tional troubleshooting procedures should be use to isolate the faulty component. As an aid to troub shooting refer to the following service aids.

Schematic Diagram, 63E81022A66
Circuit Board Detail, EPD-9972
Timing Chart, CEPD-8742

If semiconductor devices must be replaced, extreme care must be exercised when soldering. A heat sink such as a pair of pliers should be used to prevent damage from excessiv heat. Also, an isolation transformer should be used with the soldering iron to prevent current leakage from damaging the transistors. The iso lation transformer also should be used with any a-c operated test equipment.

(3) Troubleshooting Chart

SYMPTOM	PROBABLE CAUSE
None of the channel elements become energized when operating power is applied.	Faulty starting transistor (Q310), drive amplifier transistor (Q304), or diode (CR315) at emitter of starting transistor.
When operating power is applied, the selected channel element does not become activated. Channel element #1 is energized but none of the remaining channels can be selected for operation.	Astable control transistor (Q301) or transistor in 500 cps astable multivibrator is faulty. Diode gate (CR313) is open. Starting transistor (Q310) is shorted.

SYMPTOM	PROBABLE CAUSE
power is applied, one channel element be- s energized. Depressing any of remaining uttons does not cause the desired channel ent to become activated. The astable control and multivibrator transistors check good.	Faulty transistor in ring stepper circuit which is contained in energized channel element.
el switching from channel element to chan- ement cannot be halted regardless of which utton is depressed.	Astable control transistor (Q301) not functioning properly or the diode between channel elements 1 & 2 (CR314), or 4 & 5 (CR316), or 8 & 9 (CR317) is faulty.
a particular pushbutton is depressed, chan- witching continues from channel element to el element.	Switch contacts on the depressed pushbuttons are faulty. Transistor in the ring stepper circuit contained in the channel element associated with the depressed pushbutton is faulty or diode from pin #1 is open.
el element #1 is the only element which ns energized when its corresponding push- is depressed. Channel switching continues any other pushbutton is depressed.	Diode (CR314) between channels 1 & 2 is faulty. When channels 1, 2, 3 and 4 can be selected for operation but channel switching continues when any of the remaining channels are selected, check CR316 between channel elements 4 & 5. Check CR317 between channel elements 8 & 9 when channels 1 through 8 can be selected for operation but the remaining channels cannot. Faulty component in channel element associated with the first depressed pushbutton which causes continued channel switching (pushbuttons depressed in sequence from one through eleven).

) Astable Multivibrator and Astable Control Stage Test Procedure

(a) Remove all channel elements from ockets.

(b) When operating power is applied, ltivibrator should start to oscillate. The rms to indicate this condition are illus-in Timing Diagram EPD-8742. If the mul-tor does not oscillate, check Q301, Q302, 03.

(c) Connect a 10K resistor from A+ to e of Q301. The multivibrator should stop ing. If it continues to oscillate, check

Drive Amplifier and Gate Test Procedure

(a) With the astable multivibrator os-g, the waveform appearing at pin #6 of each element socket appears as shown in the timing diagram. A positive waveform is obtained until the collector of Q303 goes positive. When this occurs the waveform changes polarity and remains in that state for 5-15 microseconds (Q304 cut-off). A negative waveform is obtained each time the collector of Q303 goes positive. If the waveform at pin #6 is static or d-c, check the waveform at the base of Q304. Check Q304 if the proper waveform is obtained. If pulses do not appear at the base of Q304, diode gate CR313 or the coupling capacitor from the multivibrator to the diode is open.

(b) While observing the waveform at pin #6 of the board sockets, momentarily key the transmitter. The waveform should return to a static or d-c condition. If the pulses are still evident, check the voltages at the base of Q304 and the anode of CR313.

(6) Channel Element Checkout

To simplify waveform observation, the ring stepper circuit can be made to switch con-

tinuously by inserting a channel by-pass element into one of the sockets and depressing its associated control head pushbutton. The pulses are now repetitive rather than one-shot as in normal switching.

(7) Oscilloscope Set Up Procedure For Waveform Observation

To observe the timing diagram waveforms in their proper sequence adjust the Motorola Model T1014B Oscilloscope controls as follows:

NOTE

To simplify waveform observations, the ring stepper can be made to switch continuously by removing the RED-BRN lead from the oscillator module socket board.

(a) Adjust the vert. sensitivity control to a 2 v/cm setting.

(b) Connect a lead from pin #8 of the channel #1 socket to the ext. trigger connector on the scope.

(c) Adjust the trigger control to "ext."

(d) Turn the stability and triggering level controls fully clockwise.

(e) Connect the ground side of the scop to A+.

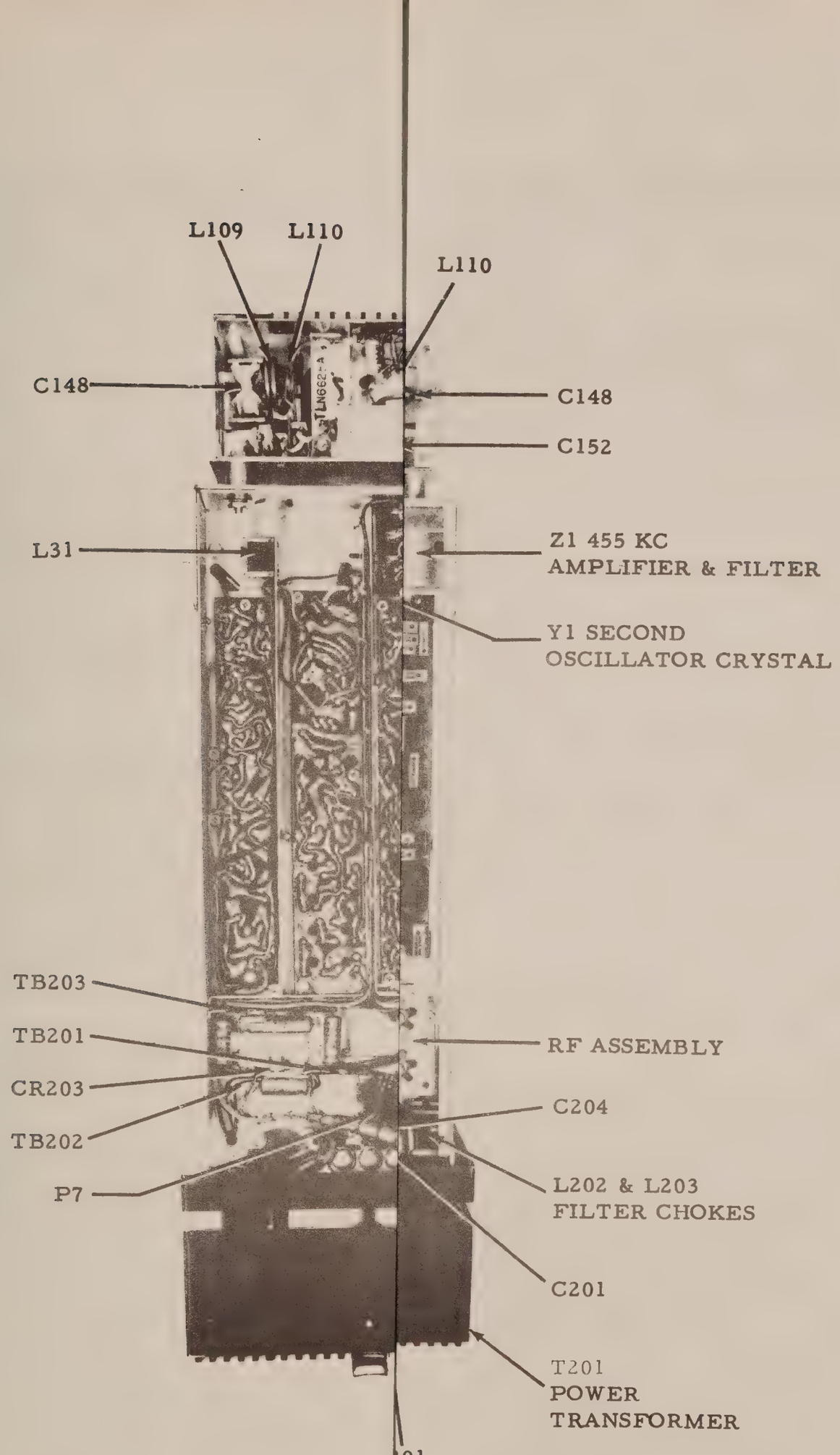
(f) Connect the scope probe to pin #8 the channel #1 socket.

(g) Position the displayed trace so tha the full waveform is visible.

(h) Turn the stability control slowly counterclockwise until the trace just disappears

(i) Turn the triggering level control cou terclockwise until the trace is locked in sync.

(j) As the scope probe is moved from point to point, the timing sequence will be as shown in Timing Diagram EPD-8742.


L109
L110
L110
C148
C148
C152
L31
Z1 455 KC
AMPLIFIER & FILTER
Y1 SECOND
OSCILLATOR CRYSTAL
TB203
TB201
RF ASSEMBLY
CR203
C204
TB202
P7
L202 & L203
FILTER CHOKES
C201
T201
POWER
TRANSFORMER

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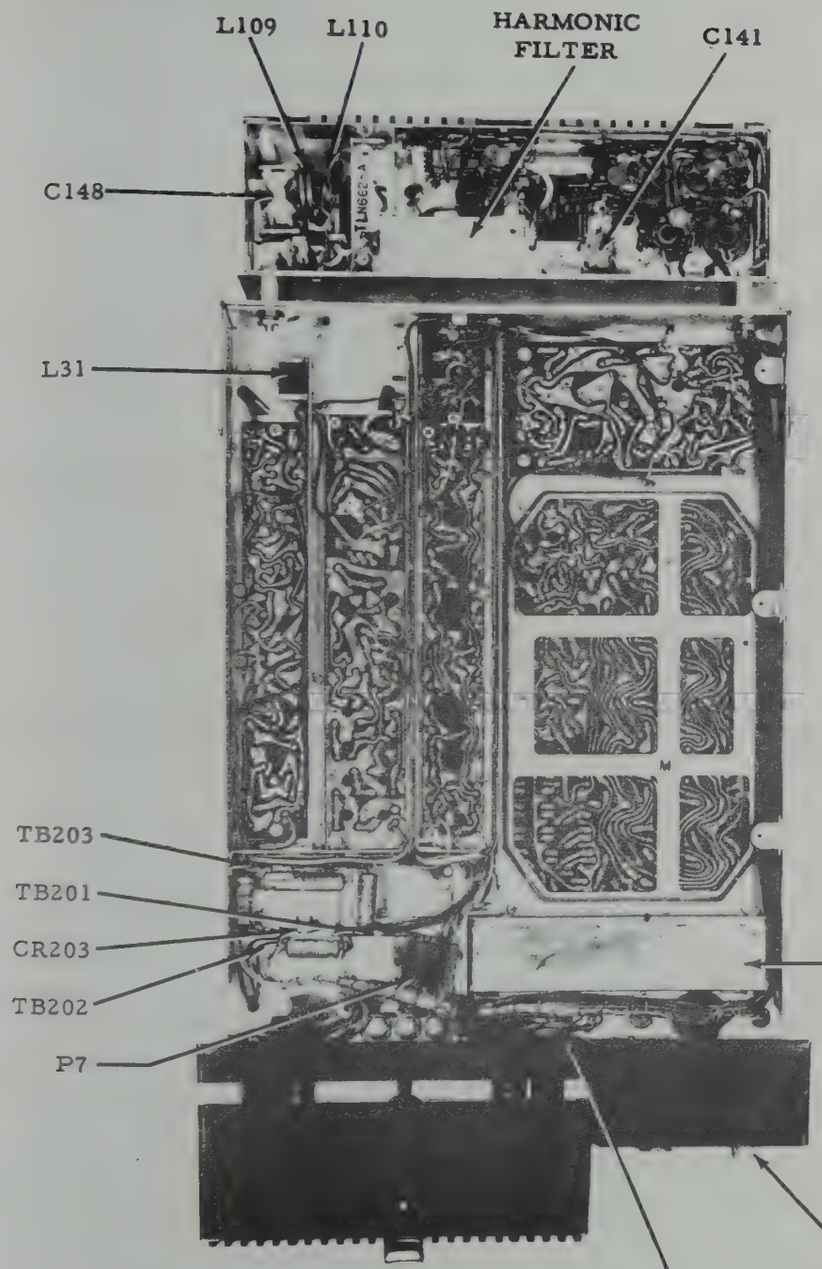
(f) Connect the scope probe to pin #8 of the channel #1 socket.

(g) Position the displayed trace so that the full waveform is visible.

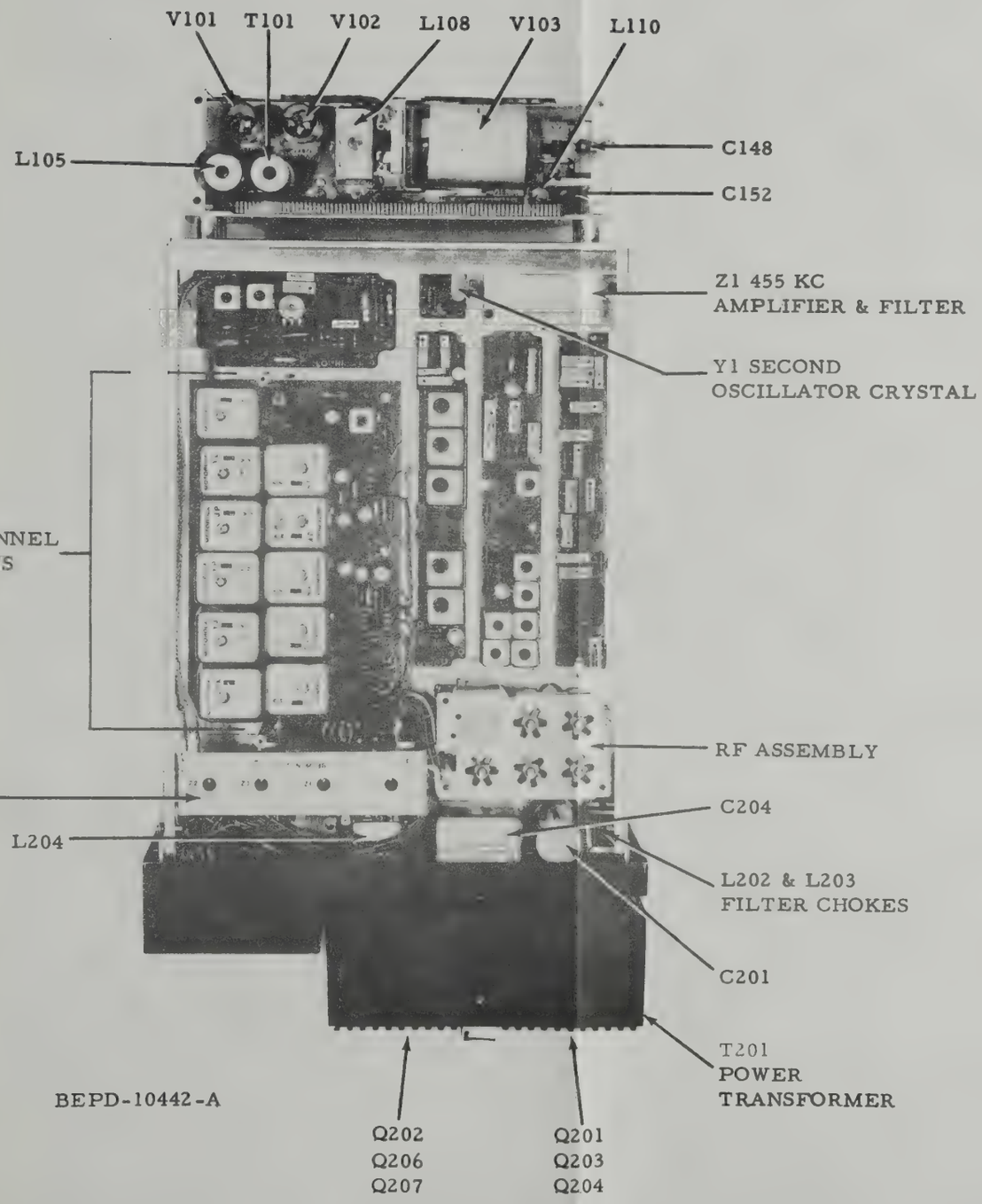
(h) Turn the stability control slowly counterclockwise until the trace just disappears.

(i) Turn the triggering level control counterclockwise until the trace is locked in sync.

(j) As the scope probe is moved from point to point, the timing sequence will be as shown in Timing Diagram EPD-8742.



BOTTOM VIEW



TOP VIEW

SUPERVISORY UNIT

MODEL TLN1034A

1. INTRODUCTION

The supervisory unit provides the facilities for operation of the IMTS car telephone and control head in the IMTS and MTS systems. It is a completely transistorized logic, tone generating and pulse decoding unit which enables radiotelephone communication between the mobile radio set and the telephone exchange. The supervisory unit mounts within the radio set housing and consists of three printed circuit boards on a fold-over bracket. The pulse decoding portion of the unit must be set up for its proper calling code ("phone number"). The assigned number is established by jumper wires on the selector board with 10 million possible code combinations using 7 digit codes. The supervisory unit is electrically connected to the radio set through a plug-in blue ribbon connector and performs the following functions.

a. The Automatic Mode of Operation:

(1) Causes the mobile to hunt over each channel in its complement for the marked idle channel (refer to paragraph 3. OPERATING SEQUENCE for definition) and when detected, locks the mobile to that channel. The idle channel is automatically selected and marked at the telephone exchange.

(2) Causes the mobile to transmit an acknowledge signal whenever it correctly receives its calling code.

(3) Turns on the mobile ringer in the control head to alert the subscriber of an incoming call when ringing signals are received by the mobile.

(4) Causes the transmission of a connect signal when the subscriber goes "off-hook" to answer or originate a call causes the transmission of a disconnect signal upon termination of the call.

(5) Causes the mobile to transmit its identification code when requested by the base station at the telephone exchange during the initiation of a call.

(6) Lights the TRANS lamp on the control head whenever the mobile transmitter is on the air.

(7) Prevents the origination of a call and lights the BUSY lamp on the control head when a busy condition exists.

(8) Converts the "phone number" dialing at the control head into tone bursts and feeds them to the transmitter.

(9) Controls handset muting to maintain privacy.

b. The Manual Mode of Operation:

(1) Enables radio set operation in MTS areas where two-tone (600 and 1500 cps) signalling is present.

(2) Activates the mobile ringer in the control head to alert the subscriber of an incoming call.

3. OPERATING SEQUENCE

a. Automatic Mode-System Operation

(1) Marked Idle Channel

When one or more unused radiotelephone channels exist in a particular area, one and only one of the unused channels is automatically selected at the telephone exchange. The base station then transmits an idle tone (2000 cps) on that channel and it is "marked" idle. The mobile units, when turned on, hunt over each channel in their complement until the presence of the idle tone is detected. The presence of the idle tone on any one channel causes the mobile to stop on that channel.

(2) Base to Mobile Call

Refer to the Base to Mobile Tone Sequence Diagram (EEPD-9490) in the left side of the instruction packet.

When a call is received at the telephone exchange and identified by the control equipment as being for a mobile unit, it is fed to the marked idle channel. The base station then replaces the idle tone with a seize tone (1800 cps) and marks a different channel idle. The mobile units previously locked on channel by the idle tone now use the seize tone as a latch. Shortly after replacing the idle tone with the seize tone, the base station outpulses the calling code of the desired mobile. The code is transmitted by interrupting the seize tone with pulses of idle tone.

After correctly receiving its calling code, the mobile transmits an acknowledge signal to the base station. This signal comprises 750 ms of a guard tone (2150 cps) and indicates reception of the code. The base station then sends alternate idle and seize tone pulses to actuate the ringer in the control head, alerting the subscriber. When the subscriber goes "off-hook" in answer to the incoming call, the mobile transmits 400 ms of a connect tone (1633 cps). The base station then removes the ringing signals and conversation may begin.

After the call is completed and the handset is hung up, the mobile sends 750 ms of a disconnect signal (alternate 25 ms pulses of disconnect (1336 cps) and guard tone). This signal informs the base station that the channel is unoccupied. The mobile is then unlatched and channel hunting begins as previously described.

If a wrong number is received for any of the digits in the mobiles calling code, a code mismatch is detected (occurs in all units except the selected mobile). This mismatch causes the mobile to search for the new marked idle channel.

When the call to the selected mobile is left unanswered (ringing continues for 45 seconds) the seize tone is removed from the channel and the mobile begins its search for the new marked idle channel.

(3) Mobile to Base Call

Refer to the Mobile to Base Tone Sequence Diagram (EEPD-9489) in the left side of the instruction packet.

If the mobile is resting on an idle channel when the subscriber goes "off-hook" to originate a call, it transmits 350 ms of guard tone and then 50 ms of connect tone. The receipt of the connect tone causes the base station to remove the idle tone from the channel and to mark a new channel idle. All mobiles now search for the new marked idle channel except that the mobile originating the call is prevented from searching while "off-hook". After a minimum of 250 ms the base station transmits a seize tone. This action primes the identifier in the calling mobile and prepares it to outpulse its seven digit identification code. When the base station is ready to receive this code, it removes the seize tone from the channel. One hundred and ninety ms later the mobile identifies itself by sending 25 ms pulses of connect tone interrupted by guard tone after each even numbered pulse and unmodulated carrier after each odd numbered pulse. When identification is completed, the handset is unmuted and a dial tone is received from the base station. Once the dial tone is received, dialing can begin.

Dialing is accomplished by alternately interrupting the guard tone with connect tone. When the dial is cocked, a set of normally open contacts are closed, the handset is muted and the guard tone is transmitted. When the dial is released, a set of normally closed contacts alternately open and close. The connect tone is transmitted while the contacts are open and the guard tone continues to be transmitted while the contacts are closed. After dialing is completed and the called party answers, conversation may follow.

When the subscriber goes "on-hook" after the call is completed, the mobile transmits the disconnect signal (alternate 25 ms bursts of guard and disconnect tone) indicating a vacant channel. The mobile is then unlatched and it proceeds to hunt for the new idle channel in preparation for the next call.

2. GUARANTEED PERFORMANCE SPECIFICATIONS

MODEL	TLN1034A
TYPE	Multi-tone
INPUT FREQUENCY	600 and 1500 cps (manual mode of operation) 1800 and 2000 cps (automatic mode of operation)
OUTPUT FREQUENCY (AUTOMATIC MODE ONLY)	1336 cps (disconnect tone) 1633 cps (connect tone) 2150 cps (guard tone)
INPUT IMPEDANCE	600 ohms
INPUT LEVEL	0.3 volt rms
PULSING SPEED	10 pps (mobile dialing or calling code information) 20 pps (identity outpulsing)
VOLTAGE REQUIREMENTS	13.6 volts d-c
STANDBY DRAIN	0.350 ampere
OPERATING TEMPERATURE	-30°C to +70°C

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

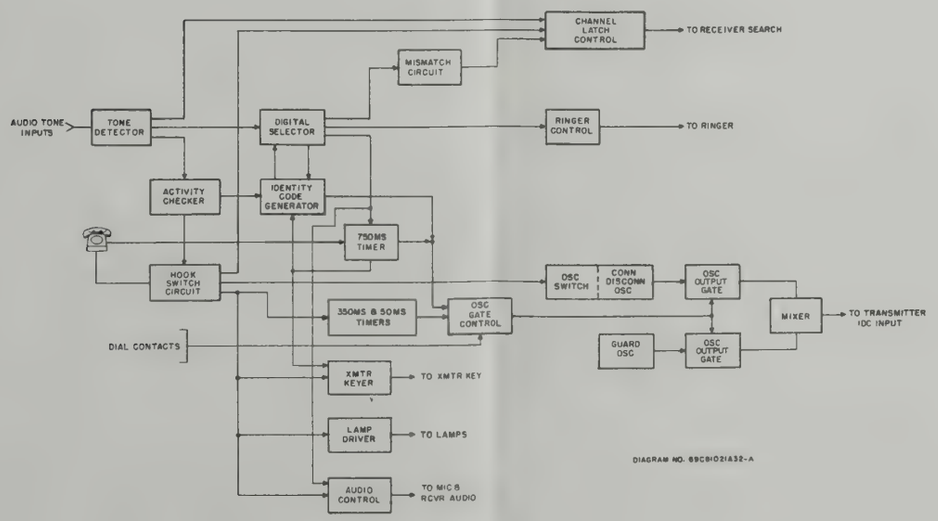


Figure 1.
SIMPLIFIED BLOCK DIAGRAM

SUPERVISORY UNIT

MODEL TLN1034A

68P81021A17-E

1. INTRODUCTION

The supervisory unit provides the facilities for operation of the IMTS car telephone and control head in the IMTS and MTS systems. It is a completely transistorized logic, tone generating and pulse decoding unit which enables radiotelephone communication between the mobile radio set and the telephone exchange. The supervisory unit mounts within the radio set housing and consists of three printed circuit boards on a fold-over bracket. The pulse decoding portion of the unit must be set up for its proper calling code ("phone number"). The assigned number is established by jumper wires on the selector board with 10 million possible code combinations using 7 digit codes. The supervisory unit is electrically connected to the radio set through a plug-in blue ribbon connector and performs the following functions.

a. The Automatic Mode of Operation:

(1) Causes the mobile to hunt over each channel in its complement for the marked idle channel (refer to paragraph 3. OPERATING SEQUENCE for definition) and when detected, locks the mobile to that channel. The idle channel is automatically selected and marked at the telephone exchange.

(2) Causes the mobile to transmit an acknowledge signal whenever it correctly receives its calling code.

(3) Turns on the mobile ringer in the control head to alert the subscriber of an incoming call when ringing signals are received by the mobile.

(4) Causes the transmission of a connect signal when the subscriber goes "off-hook" to answer or originate a call causes the transmission of a disconnect signal upon termination of the call.

(5) Causes the mobile to transmit its identification code when requested by the base station at the telephone exchange during the initiation of a call.

(6) Lights the TRANS lamp on the control head whenever the mobile transmitter is on the air.

(7) Prevents the origination of a call and lights the BUSY lamp on the control head when a busy condition exists.

(8) Converts the "phone number" dialing at the control head into tone bursts and feeds them to the transmitter.

(9) Controls handset muting to maintain privacy.

b. The Manual Mode of Operation:

(1) Enables radio set operation in MTS areas where two-tone (600 and 1500 cps) signalling is present.

(2) Activates the mobile ringer in the control head to alert the subscriber of an incoming call.

3. OPERATING SEQUENCE

a. Automatic Mode-System Operation

(1) Marked Idle Channel

When one or more unused radiotelephone channels exist in a particular area, one and only one of the unused channels is automatically selected at the telephone exchange. The base station then transmits an idle tone (2000 cps) on that channel and it is "marked" idle. The mobile units, when turned on, hunt over each channel in their complement until the presence of the idle tone is detected. The presence of the idle tone on any one channel causes the mobile to stop on that channel.

(2) Base to Mobile Call

Refer to the Base to Mobile Tone Sequence Diagram (EEPD-9490) in the left side of the instruction packet.

When a call is received at the telephone exchange and identified by the control equipment as being for a mobile unit, it is fed to the marked idle channel. The base station then replaces the idle tone with a seize tone (1800 cps) and marks a different channel idle. The mobile units previously locked on channel by the idle tone now use the seize tone as a latch. Shortly after replacing the idle tone with the seize tone, the base station outpulses the calling code of the desired mobile. The code is transmitted by interrupting the seize tone with pulses of idle tone.

After correctly receiving its calling code, the mobile transmits an acknowledge signal to the base station. This signal comprises 750 ms of a guard tone (2150 cps) and indicates reception of the code. The base station then sends alternate idle and seize tone pulses to actuate the ringer in the control head, alerting the subscriber. When the subscriber goes "off-hook" in answer to the incoming call, the mobile transmits 400 ms of a connect tone (1633 cps). The base station then removes the ringing signals and conversation may begin.

After the call is completed and the handset is hung up, the mobile sends 750 ms of a disconnect signal (alternate 25 ms pulses of disconnect (1336 cps) and guard tone). This signal informs the base station that the channel is unoccupied. The mobile is then unlatched and channel hunting begins as previously described.

If a wrong number is received for any of the digits in the mobiles calling code, a code mismatch is detected (occurs in all units except the selected mobile). This mismatch causes the mobile to search for the new marked idle channel.

When the call to the selected mobile is left unanswered (ringing continues for 45 seconds) the seize tone is removed from the channel and the mobile begins its search for the new marked idle channel.

(3) Mobile to Base Call

Refer to the Mobile to Base Tone Sequence Diagram (EEPD-9489) in the left side of the instruction packet.

If the mobile is resting on an idle channel when the subscriber goes "off-hook" to originate a call, it transmits 350 ms of guard tone and then 50 ms of connect tone. The receipt of the connect tone causes the base station to remove the idle tone from the channel and to mark a new channel idle. All mobiles now search for the new marked idle channel except that the mobile originating the call is prevented from searching while "off-hook". After a minimum of 250 ms the base station transmits a seize tone. This action primes the identifier in the calling mobile and prepares it to outpulse its seven digit identification code. When the base station is ready to receive this code, it removes the seize tone from the channel. One hundred and ninety ms later the mobile identifies itself by sending 25 ms pulses of connect tone interrupted by guard tone after each even numbered pulse and unmodulated carrier after each odd numbered pulse. When identification is completed, the handset is unmuted and a dial tone is received from the base station. Once the dial tone is received, dialing can begin.

Dialing is accomplished by alternately interrupting the guard tone with connect tone. When the dial is cocked, a set of normally open contacts are closed, the handset is muted and the guard tone is transmitted. When the dial is released, a set of normally closed contacts alternately open and close. The connect tone is transmitted while the contacts are open and the guard tone continues to be transmitted while the contacts are closed. After dialing is completed and the called party answers, conversation may follow.

When the subscriber goes "on-hook" after the call is completed, the mobile transmits the disconnect signal (alternate 25 ms bursts of guard and disconnect tone) indicating a vacant channel. The mobile is then unlatched and it proceeds to hunt for the new idle channel in preparation for the next call.

(4) Busy Conditions

If the subscriber goes "off-hook" while the mobile is not locked on an idle channel or while it is receiving signalling from the base station, the busy lamp lights on the control head and the handset remains muted. If the channel is idle at the time of "off-hook", but (a) idle tone is lost before connect tone is transmitted (channel seized by another mobile) or (b) idle tone is not lost while connect tone is being transmitted (mobile transmission not received by the base station), the busy lamp lights, the call attempt is blocked, and the mobile begins to search for the new idle channel.

b. Automatic Mode - Supervisory Unit Operation See Figure 1.

The audio output from the radio receiver is connected to the tone detector in the supervisory unit. The tone detector detects the idle tone when present, and operates the channel latch control. The channel latch control then sends a signal to the radio to stop searching. The radio, therefore, remains latched to the channel that is transmitting idle tone. If idle tone is not present the channel latch control does not operate and the radio will switch to a different channel.

(1) Base to Mobile Call

When the base station is calling a mobile, it is transmitting alternate pulses of idle and seize tone. The tones are detected by the tone detector and it generates a pulse for every transition from seize to idle tone. The pulses are fed to the digital selector where they are counted and compared with a code preset in the selector. If the incoming code matches with the preset code, an output from the selector triggers the 750 ms timer. The timer triggers the transmitter keyer and the oscillator gate control which in turn triggers the guard oscillator output gate. Guard tone is fed to the mixer which feeds the tone to the transmitter which transmits it to the base station. On receiving guard tone, the base station transmits ringing signals. The ringing signals go through the tone detection and the digital selector to operate the ringer control which rings the bell in the control head.

When the called mobile answers, the hook switch operates the hook switch circuit. The hook switch circuit locks the channel latch control to keep the mobile on channel and operates the oscillator switch to change the oscillator frequency to connect tone. The hook switch circuit also triggers the 350 ms and 50 ms timer and the transmitter keyer. The timers operate the oscillator gate control which turns on the oscillator output gates. Four hundred ms of connect tone is fed to the mixer and then transmitted. After connect tone is transmitted the hook switch circuit energizes the audio control. When the base station detects the connect tone, it removes the ringing signal and conversation may begin.

When the mobile hangs up after the call is over, the hook switch circuit unlatches and the 750 ms timer is triggered. Unlatching the hook switch circuit de-energizes the oscillator switch which changes the frequency to disconnect tone and it also turns off the audio control. The transmitter keyer is held by the 750 ms timer which also triggers the identity astable. The timer and the astable combine through the oscillator gate control and cause both oscillator output gates to transmit a disconnect signal made up of alternate pulses of disconnect tone and guard tone.

(2) Mobile to Base Call

Assume that the mobile is resting on an idle channel. When the mobile comes off hook to initiate a call, it triggers the hook switch circuit which in turn triggers the oscillator switch, 350 ms and 50 ms timers and the transmitter keyer. The oscillator frequency is changed to connect tone. The timer, operating through the oscillator gate control, controls both oscillator output gates and the mixer to initiate transmission of 350 ms of guard tone followed by 50 ms of connect tone and then guard tone again.

If loss of idle tone is detected while connect tone is being sent, the mobile will transmit guard tone after the 50 ms of connect tone. The base station will subsequently transmit seize tone and will then drop it. The loss of seize tone is detected by the tone detector and it unlatches the activity checker. When the activity checker turns on the identity code generator, the identity code generator sends pulse signals to the digital selector and to the oscillator output gates via the oscillator gate controls. The pulses sent to the digital selector are counted and compared to the preset code. The digital selector, in turn, controls the identity code generator so that groups of signal pulses are sent to the oscillator gate control. These pulse groups correspond identi-

cally with the mobile code number. The mobile therefore, identifies itself with pulses of connect tone and guard tone. When identification is complete the handset becomes activated. After the base station receives the mobile identity pulses, it sends dial tone to the mobile subscriber. The mobile subscriber then dials the desired number. The dial contacts then control the oscillator output gates via the oscillator gate control. Pulse groups of connect tone and guard tone, corresponding to the number dialed are, therefore, transmitted. When the mobile hangs up, a disconnect signal is transmitted as previously described.

c. Manual Mode of Operation

In the manual mode of operation, all tone signalling (600 and 1500 cps) originates from the base station. When a predetermined sequence of tones is received, the ringer in the control head is turned on. This alerts the subscriber that a call is being directed to the mobile. The ringer operates continuously until the handset is removed from its holder in answer to the call or until a reset pulse is transmitted from the base station.

A mobile call is initiated by contacting the mobile service operator at the telephone exchange. The radio transmitter is turned on only when the push-to-talk button on the handset is pressed. During this time, the receiver remains on (duplex operation) to allow the subscriber to hear the other party. An illuminated GRN lamp on the control head indicates the transmit condition.

For a brief interval after going "off-hook", transmission is prevented. That is, pressing the push-to-talk button does not turn on the transmitter. This prevents the subscriber from accidentally keying the transmitter if the button is depressed while going "off-hook".

4. FUNCTIONAL DESCRIPTION

a. Automatic Mode of Operation

(1) Base to Mobile Call

Refer to figure 2 and the appropriate timing diagrams supplied with this manual.

The mobile radio set, when turned on hunts over each channel in its complement until the idle tone transmitted from the base station is detected. The presence of idle tone on any one channel causes the idle tone Schmitt trigger circuit to become activated. This action locks the channel latch control circuit and the mobile is latched to the marked idle channel. When a call is received at the telephone exchange and identified as being for a mobile unit, the base station indicates the marked channel busy by replacing idle tone with seize tone. This activates the seize tone Schmitt trigger circuit and as a result, the activity checker circuit is turned on. The activity checker resets the pulse and digit counters in preparation for receiving coded calling signals and turns on the hook inhibit gate circuit to prevent a mobile from originating a call on the channel.

Shortly after replacing idle tone with seize tone, the base station transmits the calling code (phone number) of the desired mobile. Each digit of the code comprises alternate 50 ms bursts of idle and seize tone interrupted by approximately 300 ms of seize tone between each digit. The number of idle tone bursts corresponds to the digit transmitted. For example, if the code digit to be transmitted is three (3), then three bursts of idle tone are sent in the code digit pulse train.

Assume that the first two digits of the mobiles calling code are 3 and 1. When the first digit (3) of the code is received, the tone bursts are routed from the output of the receiver to the amplifier and clipper stage in the supervisory unit. From this stage the signals are fed to the idle and seize tone detectors, to their associated Schmitt triggers and then to the detector bistable. The detector bistable develops a pulse each time a frequency shift occurs from seize to idle tone (3 pulses). These pulses are then counted by the pulse counter and compared with a code preset into the digit counter. When a match occurs, the digit counter is primed so that it can be advanced to the next element in its complement.

The three pulses from the detector bistable are also applied to a pulse amplifier in the interdigit timer. The output from the pulse amplifier is integrated and fed to a Schmitt trigger. Integrating the output delays the return of the interdigit timer to its original state during the receipt of signalling from the base station. During the time between receipt of the first and second code digits, the interdigit timer relaxes and generates a pulse which is fed to the mismatch gate and to the pulse and digit counters.

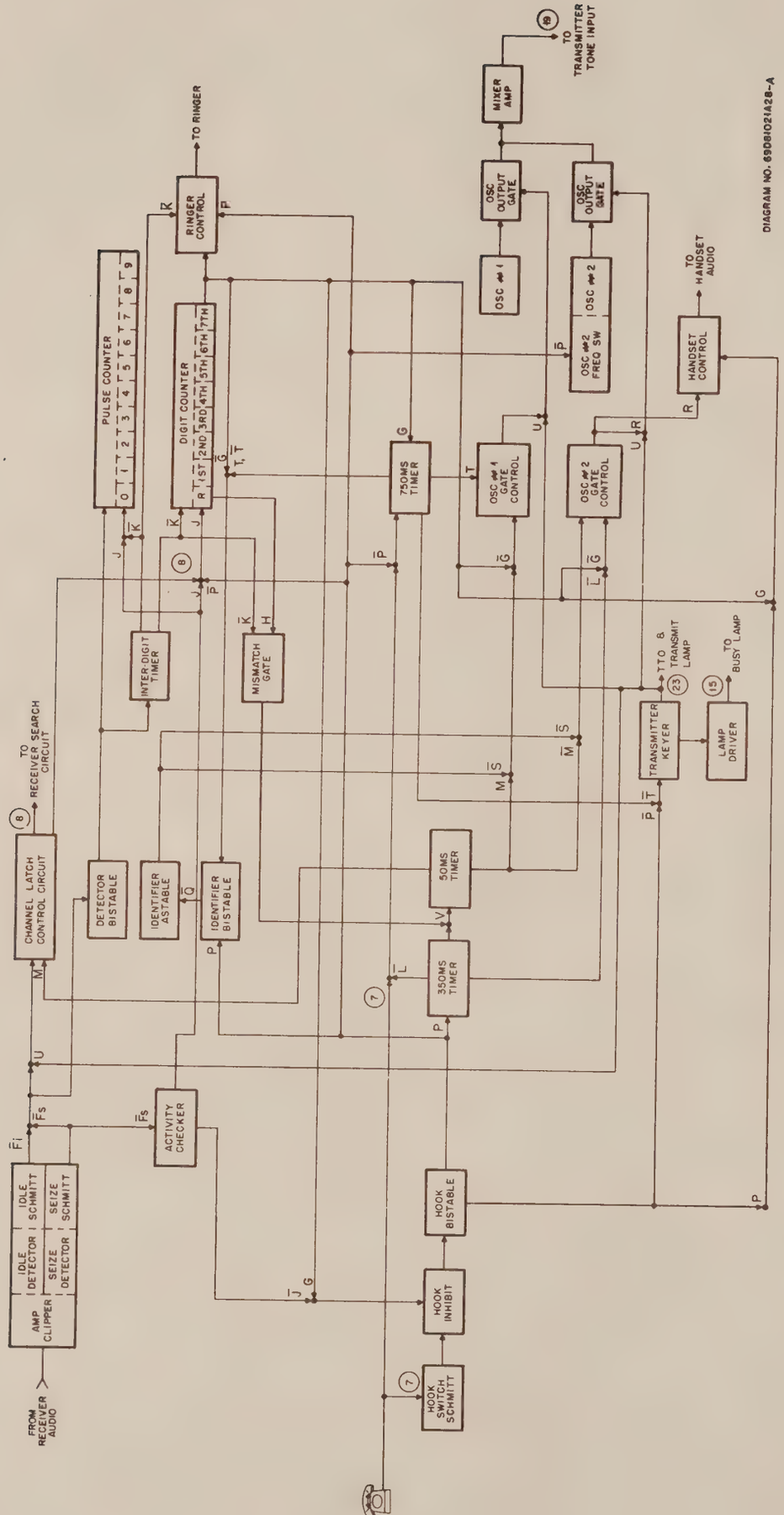


Figure 2
BASE TO MOBILE BLOCK DIAGRAM

This resets the pulse counter and steps the digit counter from the reset element to the first digit element in its complement. The mismatch gate is turned on. However, its output is inhibited by the digit counter, since it has been advanced from the reset stage and it is prevented from unlatching the channel latch control circuit.

When the second digit (1) is received, a similar procedure occurs. The interdigit timer is turned on, the pulse counter counts to 1 and a match occurs. The digit counter is primed so that it can be advanced to the next element in its complement, and the output of the mismatch gate is inhibited. The interdigit timer then relaxes and generates an output pulse. As a result, the pulse counter is reset, the digit counter is stepped to the next element in its complement, and the mismatch gate is triggered. Since its output is inhibited, the channel latch control circuit is again prevented from being unlatched.

After correctly receiving the seventh or last digit of the calling code in a similar manner, the digit counter triggers the selector inverter which, in turn, triggers the 750 ms timer, primes the ringer control circuit, inhibits further inputs to the digit counter and turns on one of the inputs to the oscillator #1 control gate. The 750 ms timer, when triggered, turns on the transmitter keyer, fully activates the oscillator #1 control gate and permits the acknowledge signal to be transmitted (750 ms of guard tone).

Upon receipt of the acknowledge signal, the base station sends a series of alternate idle and seize tone pulses to actuate the mobile ringer. When these pulses are received and recognized by the mobile, the operating sequence previously described is repeated. When the interdigit timer is triggered by the detector bistable, a signal is applied to the ringer control circuit and the ringer on the control head is turned on. The digit counter, however, is inhibited from stepping and the last element in its complement remains on.

When the handset is removed from its holder to answer the incoming call, the hook bistable is triggered by the hook switch Schmitt trigger. Consequently, the oscillator #2 frequency switch (Q104) changes state to switch the oscillator #2 frequency from 1336 cps (disconnect tone) to 1633 cps (connect tone). In addition, the 350 ms timer and transmitter keyer are turned on. The transmitter keyer turns on the transmitter and keeps the channel latch control circuit locked to prevent channel hunting. The 350 ms timer initiates the transmission of connect tone during its period of operation (350 ms). After it relaxes, it turns on the 50 ms timer for the transmission of an additional 50 ms of connect tone (total of 400 ms). While transmission is in progress, the busy lamp driver is cut off to prevent illumination of the busy lamp on the control head and the handset control circuit is primed for operation. After the transmission of connect tone, the handset control circuit activates the handset and conversation follows.

When the call is completed and the handset is returned to its holder, the hook bistable becomes reset by a signal from the hook switch Schmitt trigger. When this occurs, the 750 ms timer is turned on and the oscillator #2 frequency switch changes state to switch the oscillator #2 frequency from 1633 cps (connect tone) to 1336 (disconnect tone). The 750 ms timer, when triggered, turns on the identifier bistable which activates the identifier astable to initiate the transmission of the disconnect signal (alternate 25 ms pulses of disconnect and guard tone for 750 ms).

After the transmission of the disconnect signal, the 750 ms timer relaxes and turns off the transmitter keyer. As a result, the transmitter is deactivated and the channel latch control circuit is unlocked. The mobile then begins its hunt for the new marked idle channel. When the marked idle channel is detected, the channel latch control circuit is locked and the search action is stopped.

If a wrong number is received for any of the digits in the calling code, the output of the mismatch gate does not become inhibited by the digit counter. Therefore, when the interdigit timer relaxes and turns on the mismatch gate after receiving the wrong digit, the mismatch gate output unlocks the channel latch control circuit. The result is that the mobile is released and the search for the new marked idle channel begins.

If a call is left unanswered for 45 seconds after ringing begins, the base station removes seize tone from the channel. This unlocks the channel latch control circuit, resets the digit counter, and again the mobile begins searching for the new marked idle channel.

(2) Mobile to Base Call

Refer to figure 3 and the appropriate timing diagrams supplied with this manual.

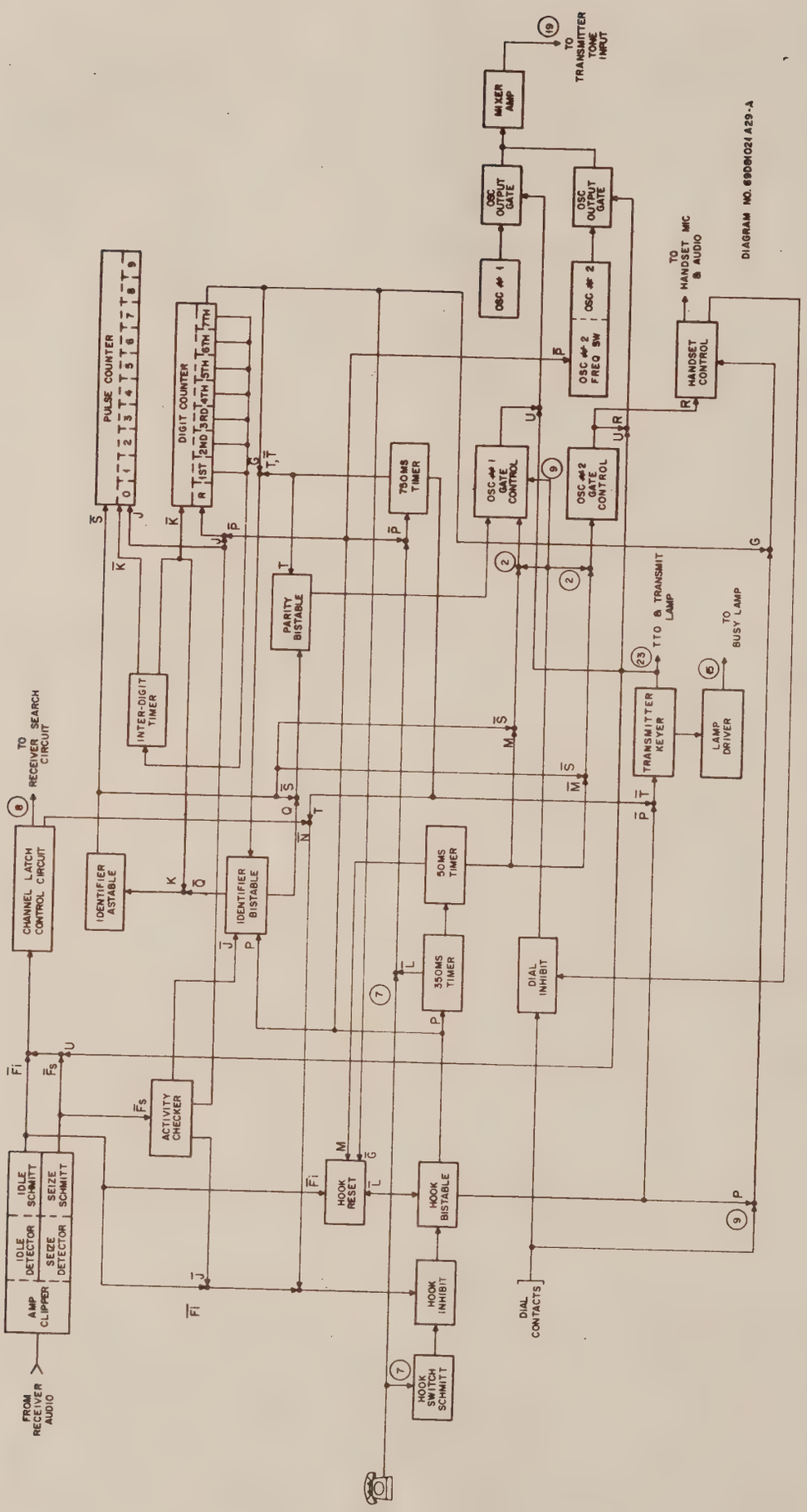


Figure 3.
MOBILE TO BASE BLOCK DIAGRAM

When the subscriber goes "off-hook" to initiate a call, the hook switch Schmitt trigger becomes activated and a pulse is derived from its output. If the mobile is receiving idle tone at the time of "off-hook", this pulse is fed to the hook bistable via the hook inhibit gate. Consequently, the hook bistable is triggered and as a result, the following events occur:

(a) The oscillator #2 frequency switch is turned off to change the oscillator #2 frequency from 1336 cps (disconnect tone) to 1633 cps (connect tone).

(b) The transmitter keyer is turned on. This turns on the transmitter and the TRANS lamp on the control head, locks the channel latch control circuit to prevent channel hunting while "off-hook" and primes the mixer gate circuit.

(c) The identifier bistable and handset control circuit are primed for operation. The identifier bistable, in the primed or unprimed condition prevents operation of the identifier astable.

(d) The 350 ms timer is turned on to initiate the transmission of guard tone for the period of its operation (350 ms).

If after going "off-hook", the mobile fails to receive idle tone for a period of 350 ms (channel seized by another mobile) or continues to receive idle tone for more than 400 ms (mobile transmission of connect tone not received by base station), the call attempt is blocked. The hook reset gate restores the hook bistable to its original state, the busy lamp driver illuminates the BUSY lamp on the control head and the circuits described in the preceding paragraph are returned to their initial condition. If the mobile is receiving seize tone at the time of "off-hook" (signalling from base station present), the activity checker turns off the hook inhibit gate. This prevents the pulse generated by the hook switch Schmitt trigger (during off-hook) from activating the hook bistable. Therefore, the normal operating sequence is obstructed and the subscriber is prevented from initiating a call on that channel.

Three hundred and fifty (350) milliseconds after being triggered by the hook bistable, the 350 ms timer relaxes and turns on the 50 ms timer. When this occurs, the oscillator #2 control gate is turned on and 50 ms of connect tone is transmitted. At the same time, the oscillator #1 control gate is turned off and the transmission of guard tone is prevented. In addition, the hook bistable is prevented from being reset by the hook reset gate when idle tone is subsequently removed from the channel. Resetting the hook bistable would, as previously described, block the attempted call.

Upon receipt of connect tone from the mobile, the base station removes idle tone from the channel. After a pause of at least 250 ms, it transmits 50 ms of seize tone. This tone signal is routed from the receiver to the amplifier and clipper stage, to the seize tone detector and then on to the seize tone Schmitt trigger. The Schmitt trigger turns on the activity checker and, as a result, the pulse and digit counters are reset. The base station then removes seize tone from the channel in preparation to receive the mobiles identification code. With the removal of seize tone, the seize tone Schmitt trigger is restored to its original state, the activity checker drops out, and the identifier bistable becomes activated. When this occurs, the parity bistable and identifier astable are unclamped. The identifier astable then starts oscillating and square pulses are generated at a 50 ms repetition rate.

Each pulse from the astable (1) turns on the oscillator #2 control gate for a 25 ms period during its negative half cycle, (2) activates one input of the oscillator #1 control gate for a 25 ms period and (3) triggers the pulse counter and parity bistable once during each complete cycle (50 ms). When the oscillator #2 control gate is turned on, 25 ms of connect tone is transmitted. The parity bistable, when triggered by every other pulse from the identifier astable (2nd, 4th, 6th, etc), activates one input of the oscillator #1 control gate until the next pulse is received from the astable. The oscillator gate, however, only becomes fully activated when both inputs to the gate occur simultaneously and are of like polarity. This occurs after an even numbered pulse of connect tone (counting in sequence from the initial pulse generated by the identifier astable) and guard tone is transmitted.

In summation, for every odd numbered pulse generated by the identifier astable (1st, 3rd, 5th, etc) the mobile sends 25 ms of connect tone and then unmodulated carrier until the next pulse is developed by the astable. For every even numbered pulse, the mobile transmits 25 ms of connect tone and then guard tone until the next pulse is produced by the astable. If the astable is turned off after developing an even number of pulses, guard tone is transmitted for 190 ms (interdigit time). If turned off after an odd number of pulses are developed,

unmodulated carrier is transmitted for 190 ms.

Assume that the first two digits of the code are 3 and 1. As the pulse counter is triggered by the pulses from the identifier astable, each pulse is counted. This procedure continues until a code match occurs between the pulse and digit counters (code set into digit counter matches the number of pulses counted by the pulse counter). Since the first digit of the code is 3, a match occurs when the third pulse from the identifier astable is applied to the pulse counter. Consequently, an output is obtained from the digit counter and applied to the interdigit timer. The interdigit timer then couples a clamping voltage to the identifier astable. As a result, the identifier astable is turned off after generating three pulses. As previously described, this results in the transmission of three 25 ms pulses of connect tone interrrupted by (1) 25 ms of unmodulated carrier after the first pulse, (2) 25 ms of guard tone after the second pulse, (3) 190 ms of unmodulated carrier after the last pulse of connect tone. When transmission of the unmodulated carrier is complete, the interdigit timer relaxes and produces a pulse. This pulse steps the digit counter from the reset to the first digit element in its complement, resets the pulse counter, and turns on the identifier astable.

The second digit (1) of the identification code is now transmitted and a similar procedure occurs. The pulse counter counts one pulse from the identifier astable, a match occurs the interdigit timer is activated and the astable is turned off after developing one pulse. This results in the transmission of one pulse of connect tone. Since the total number of the pulses generated by the astable is now even (3 + 1 = 4), the mobile transmits 190 ms of guard tone. At this time, the interdigit timer relaxes and a pulse is derived from its output. The digit counter is then stepped from the first to the second digit element in its complement, the pulse counter is reset and the identifier astable is turned on to generate the third digit.

After the remainder of the code digits are outpulsed in a similar manner, a pulse from the output of the selector inverter triggers the identifier bistable and handset control cirsuit. Consequently, the identifier astable is turned off and the handset is activated to receive dial tone from the base station.

When dial tone is received by the mobile, the phone number of the desired station may be dialed. The dialing action of the control head is converted into alternate bursts of guard and connect tone. When the dial is cocked, a set of normally open contacts are closed. This turns on the oscillator #1 control gate, which results in guard tone being transmitted. When the dial is released, another set of contacts alternately open and close. As a result, the contacts are open, the oscillator #2 control gate is turned on, the oscillator #1 control gate is turned off and 60 ms of connect tone is transmitted. When the contacts are closed, the opposite occurs and 40 ms of guard tone is transmitted.

When the mobile subscriber goes "on-hook" after completion of the call, the hook bistable is reset by a pulse from the hook switch Schmitt trigger. Consequently, the 750 ms timer is triggered and the oscillator #2 frequency switch is turned on to change the oscillator #2 frequency from 1633 cps (connect tone) to 1336 cps (disconnect tone). The 750 ms timer, when triggered, turns on the identifier bistable, inhibits the inputs to the interdigit timer and clamps the parity bistable off. As a result, the identifier astable oscillates and alternate 25 ms bursts of disconnect and guard tone are transmitted for 750 ms.

After the disconnect signal is sent, the 750 ms timer relaxes and turns off the transmitter keyer. This deactivates the transmitter and unlocks the channel latch control circuit. The mobile then commences to search for the new marked idle channel. When idle tone is detected by the mobile, the channel latch control circuit is locked and the search action is stopped.

b. Manual Mode of Operation

(1) Base to Mobile

When the manual mode of operation is selected at the control head, the 1500/2000 detector and 600/1800 detector in the input circuitry of the supervisory unit are tuned to 1500 and 600 cps respectively. In addition, the identifier circuits, the oscillator circuits, and handset and channel latch control circuits are inhibited. When a mobile is called, the base station transmits its calling code. The code consists of seven groups of alternate 600 and 1500 cps tones modulating a carrier. These tones are fed from the output of the receiver into the input circuitry of the supervisory unit. In the supervisory unit, each frequency shift from 600 to 1500 cps or from 1500 to 600 cps produces a pulse. These pulses are

counted and compared with a code preset into the digit counter. When the proper code is received, the ringer in the control head is turned on and ringing occurs immediately.

As an example, assume that the first two digits of the mobiles calling code are 3 and 1. When the 600 cps tone is first detected, an output from that detector pulls in the activity checker. An output from the activity checker resets the pulse and digit counters.

When the first digit (3) of the code is received, the signals are fed from the receiver to the amplifier and clipper stage. From this stage the signals are applied to the idle and seize tone detectors, to their associated Schmitt triggers and then on to the detector bistable. The detector bistable develops a pulse each time a frequency shift occurs from 600 to 1500 cps or 1500 to 600 cps (3 pulses). These pulses are then counted by the pulse counter and compared with a code preset into the digit counter. When a code match occurs, the digit counter is primed for a stepping pulse from the interdigit timer.

The pulses from the detector bistable are also applied to the pulse amplifier in the interdigit timer. The output derived from the pulse amplifier is integrated and fed to the Schmitt trigger.

During the time between the receipt of the first and second digits, the interdigit timer relaxes. This generates a pulse that resets the pulse counter and steps the digit counter from the reset position to the first digit element in its complement.

When the second digit (1) is received, a similar procedure occurs. The pulse counter counts to 1, a match occurs, the digit counter is primed for the stepping pulse from the interdigit timer, the interdigit timer becomes activated, the digit counter is allowed to step to the second element in its complement and the pulse counter is reset in preparation to receive the next group of pulses from the detector bistable.

After correctly receiving the seventh or last digit of its calling code, in a similar manner, a signal is obtained from the output of the digit counter and applied to the ringer control circuit. This activates the mobile ringer and ringing continues until the time of "off-hook" or until a reset pulse is transmitted by the operator at the telephone exchange.

When the handset comes "off-hook", the handset becomes activated. As the mobile comes "off-hook", the off-hook signal is coupled to the hook inhibit gate and temporarily delays the hook switch Schmitt trigger pulse from triggering the hook bistable. This prevents the transmitter from being accidentally keyed if the push-to-talk button is depressed while going "off-hook". When the button is pressed, after sufficient delay, the hook switch Schmitt trigger is turned on and a pulse is obtained from its output and coupled to the hook bistable. The hook bistable is triggered which, in turn, activates the transmitter keyer. The transmitter keyer then turns on the transmitter permitting radiotelephone communication between stations.

If a wrong number is received for any of the code digits, the digit counter does not become primed for the pulse from the interdigit timer. Therefore, the digit counter is inhibited from stepping to the next digit element when the interdigit timer relaxes. This causes the reset element to become activated and the digit counter is reset.

(2) Mobile to Base

When the handset is removed from its holder, the transmitter is keyed as described in the preceding paragraphs. After contacting the mobile operator at the telephone exchange and being connected to the called party, push-to-talk conversation may begin.

5. CIRCUIT ANALYSIS

a. Introduction

The characteristics of a transistor used in switching circuits differ from those used in the r-f or i-f stages of a radio. To familiarize the reader with some of these differences, this section contains an explanation of some basic switching circuits used in this unit.

b. Basic Circuits

A transistor switching circuit is a device that has a high resistance in one state (cut-off) and a low resistance in the other (full saturation). If the emitter to base junction of a germanium transistor is unbiased or reversed biased, the transistor is cut off and the collector junction becomes a high resistance. Forward biasing the emitter to base junction by about 150 mv drives the transistor into saturation.

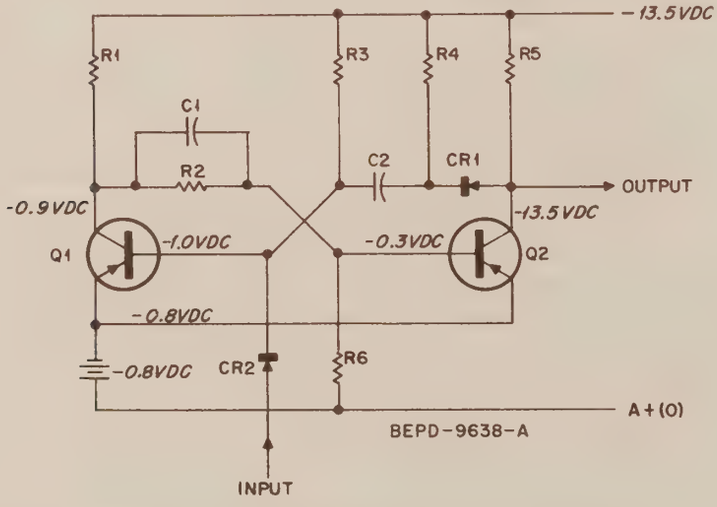
The collector junction becomes a low resistance and the collector potential approaches the emitter potential.

NOTE

All voltages shown are with 13.6 nominal voltage to the supervisory unit. The supervisory unit has its own filter network which drops the voltage about 0.1 volt. Therefore, the supply voltage to the individual circuits is about 13.5 volts. The voltages shown are mainly for purposes of explanation and may vary from unit to unit due to the tolerances of the components and the variable characteristics of the transistors.

(1) Monostable Multivibrator

The monostable multivibrator (figure 4) is a relaxation oscillator which consists of two PNP transistors coupled back to back. One coupling network between transistors is a capacitor (a-c), the other a resistor (d-c). Because of this arrangement, the monostable has one stable and one unstable operating state. When a signal of correct amplitude and polarity is applied to this circuit, the monostable is switched from its initial stable state to its unstable operating state. This mode of operation exists for a predetermined length of time, after which, the monostable reverts to its original state and remains there until another input signal is applied.



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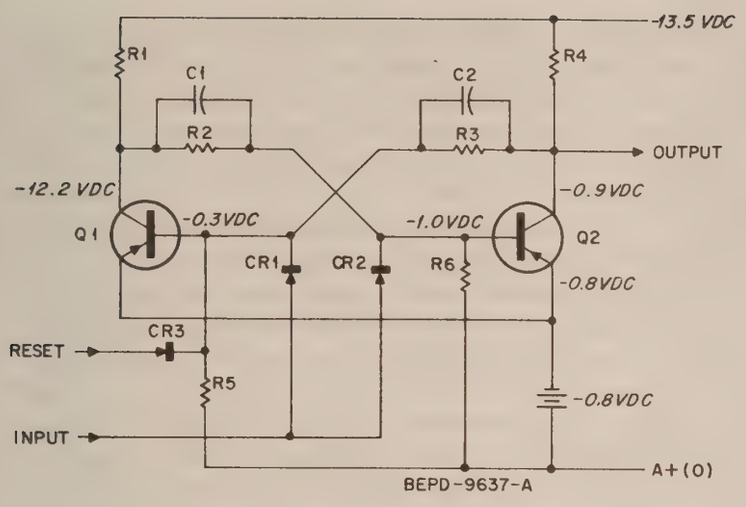
Figure 4.
MONOSTABLE MULTIVIBRATOR CIRCUIT

The biasing arrangements of the monostable multivibrator illustrated in Figure 4 are such that when operating power is applied, Q1 is saturated and Q2 is cut off. The base of Q1 is connected to A- through resistor R3 and therefore its potential is fixed at approximately 0.2 volt more negative than the emitter voltage (Q1 forward biased). Resistors R2 and R6 determine the voltage at the base of Q2. This voltage is approximately 1/3 the voltage at the collector of Q1 and 0.5 volt more positive than the voltage at the emitter of Q2. Thus, at turn-on, Q1 is saturated and Q2 is reverse biased (cut off).

When a positive pulse is applied to the base of Q1 through CR3, Q1 is driven toward cutoff and the voltage at its collector goes negative. This negative-going voltage is coupled through C1 and R2 to the base of Q2 and it begins to conduct. When this occurs, the voltage at the collector of Q2 goes positive and capacitor C2 discharges through Q2, CR1 and R3. This causes a voltage drop across R3 which drives the base of Q1 more positive than the emitter and the stage is cut off. As C2 becomes less charged, the discharging current gradually decreases and the voltage drop across R3 is reduced. As a result, the base of Q1 again becomes negative with respect to the emitter. Transistor Q1 then begins to conduct and the voltage at its collector goes positive along with the base of Q2. When this occurs, transistor Q2 is cut off and capacitor C2, which had previously discharged, recharges through Q1 and R4. The monstable circuit then reverts to its original state and remains there until another input pulse repeats the entire cycle. The duration of the output from the circuit is determined primarily by the value of C2 and R3.

(2) Bistable Multivibrator

Another basic network used in switching circuitry is a bistable multivibrator or flip-flop (figure 5). It is similar to the monostable multivibrator. The main difference is that d-c cross coupling exists between both transistors as opposed to only one d-c cross coupling network in the monostable multivibrator. The flip-flop, therefore, has two stable states of operation. With the initial application of d-c power, one transistor saturates and the other is cut off. Each transistor is held in its particular state by the condition of the other.



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Figure 5.
BISTABLE MULTIVIBRATOR CIRCUIT

Assume that Q2 is saturated (on). Note that the emitter to base junction of Q2 is forward biased by 0.2 volt and the emitter and collector are at approximately the same potential. The collector voltage on Q2, which is fed back to the base of Q1 through the divider R3 and R5, keeps the base of Q1 sufficiently positive (reverse biased) to keep Q1 turned off. Therefore, Q1 is a high resistance and has a large voltage drop (12 volts) across it. The collector voltage on Q1, which is fed back to the base of Q2 through the divider R2 and R6, keeps the base of Q2 sufficiently negative to keep Q2 saturated.

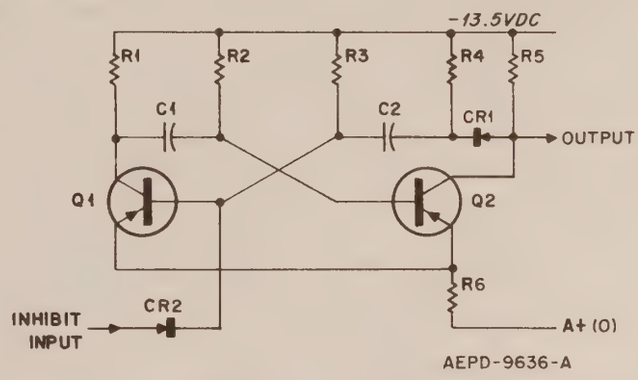
When a positive-going transition (trigger) is applied to the input, it is coupled through CR2 (because of its more negative cathode) to the base of Q2. The positive transition causes the base of Q2 to go positive and Q2 begins to turn off. The collector of Q2 then starts to go negative and this transition, coupled through C2 and R5, drives the base of Q1 negative. As the base-emitter junction of Q1 becomes forward biased, Q1 starts to turn on and its collector begins to go positive. This positive rise, coupled back through C1 and R2, reinforces the original trigger and this action continues until Q1 is fully saturated and Q2 is cut off. The circuit has now changed its state.

The next positive trigger on the input is coupled through CR1, and in the manner previously described, Q1 is cut off and Q2 is saturated. The circuit has again changed state.

It is often necessary to reset the flip-flop before a sequence of events can be performed. To accomplish this, a positive pulse is applied to the base of Q1. Therefore, if Q1 is conducting at the time of reset, it goes into cut off and Q2 goes into saturation. If Q1 is cut off at the time of reset, the circuit remains as is.

(3) Astable Multivibrator

The astable multivibrator (figure 6) is a free running oscillator which also consists of two collector-coupled PNP transistor stages. Unlike the bistable or monostable multivibrator, it contains two capacitor coupling networks (a-c) and no resistor coupling networks (d-c) between transistors. It therefore, has two unstable operating states.



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Figure 6
ASTABLE MULTIVIBRATOR CIRCUIT

Because of variations in transistors and component tolerances, one transistor conducts more heavily than the other when initial d-c power is applied. Assume that Q2 conducts more heavily than Q1 at turn-on. When this occurs, the collector voltage of Q2 becomes more positive and capacitor C2 charges through Q2 and R3. The voltage drop across R3 caused by the charging current is such that the forward bias at the base of Q1 decreases. With its forward bias decreased, the potential at the collector of Q1 increases. This negative-going voltage is coupled to the base of Q2 through C1 and Q2 is driven further toward saturation. This action continues until Q2 is in saturation and Q1 is cut off. At this time, C2 fully charges, the charging current through R3 is reduced, and a forward bias is established at the base-emitter junction of transistor Q1. Transistor Q1 then begins to conduct, the previously described operation is repeated for this stage and the multivibrator oscillates continuously. The duration of the output in one mode of operation is determined by C1 and R2 and the duration of the output on the other mode is determined by C2 and R3.

The oscillating period of the multivibrator can be controlled by a positive pulse input to the base of Q1 (or Q2). This positive voltage input, while applied, inhibits the operation of the multivibrator by keeping Q1 cut off and Q2 in saturation. The same pulse input also serves to reset the multivibrator so that the output oscillations start on the same time cycle.

(4) Ring Counter and Pulse Counter

The ring counter is a circuit that simulates a stepping switch, i.e., with each successive input pulse a different element is energized. Each element in this ring counter, except for the first, uses a direct coupled PNP NPN transistor pair. Whenever an input pulse is applied to the ring counter, an entirely different transistor pair becomes saturated. The following description is for operation of a four element ring counter. A counter with additional stages would operate similarly.

The driver and the four element circuits are shown in figure 7. The driver transistor (Q1) is normally saturated since the base emitter junction is forward biased. Assume that the reset element of the ring counter Q2, is initially in the fully saturated or on condition. The coupling capacitor (C3) between the reset and first direct coupled digit element circuit has almost no charge on it. The other two coupling capacitors, C4 and C5, are charged to about 13 volts in the polarity shown.

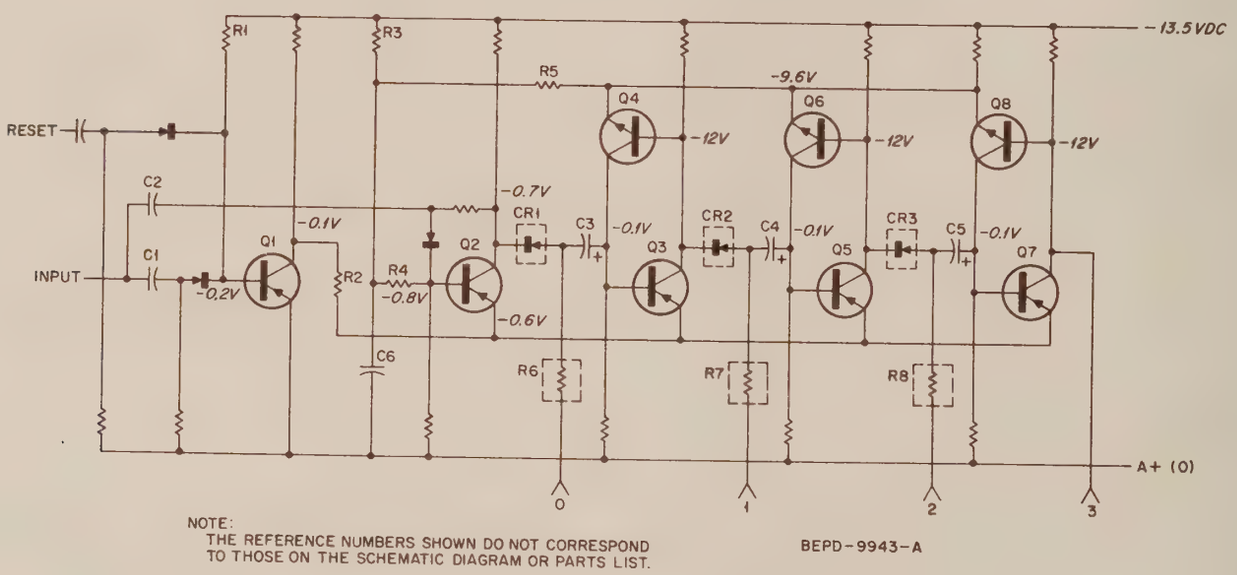


Figure 7.
RING COUNTER CIRCUIT

Because of the time constant of C1 and R1, a positive drive pulse applied to the base of Q1 will cut it off for approximately 10 us. When this occurs, the negative-going voltage which appears at the collector of Q1 is coupled through R2 to the emitters of Q2, Q3, Q5 and Q7.

The drive pulse that is applied to the base of Q1 is also coupled to the base of Q2 via capacitor C2. In this case, Q2 is cut off for approximately 50 us (time constant of C2, R4 and R3). When Q2 is cut off, a negative pulse is coupled from the collector through C3 to the base of Q3, attempting to turn it on. Transistor Q3 remains cut off, however, since its emitter is biased negative by the signal from the collector of Q1. Approximately 10 us later when Q1 again saturates, a positive-going voltage is reapplied to the emitters of the PNP transistors in the digit counter elements. Transistor Q3 is then turned on, its collector goes positive and drives the base of Q4 positive causing it to conduct. This action continues until Q3 and Q4 are both in saturation.

Transistor Q2 is held in cut-off for an additional 40 us after Q1 is turned on. The duration of the positive pulse at its base causes this to occur. During this time interval, C6 discharges to a positive potential through R5 and the low saturation resistance of Q4, (Q6 or Q8 when the third or fourth element is on). The resulting positive potential on C6 holds Q2 cut-off as long as any other elements in the ring counter are on.

When Q3 and Q4 are both in saturation, C4 discharges through Q1 and Q3 (or R7 if that portion of the circuitry is used) while C5 remains charged. When the next drive pulse is applied to the driver, (Q1), it is again turned off. As a result, a negative pulse is applied to the emitters of the PNP transistors in the ring counter circuit. This turns off Q3 which, in turn, cuts off Q4. When Q3 is cut off, a negative pulse is coupled through C4 to the base of Q5 and, as previously described, the third element is activated.

With the addition of an inhibiting network (e. g. CR1 and R6) between each element, the ring counter can be prevented from stepping to the next element in its complement. When a negative signal is applied to the network resistor, its associated diode becomes reverse biased. This inhibits any output from the activated element and prevents the next element from being turned on. Therefore, when a drive pulse is applied to Q1, the digit counter is prevented from stepping to the next element.

When a reset pulse is applied to Q1, it goes into cut-off for approximately 100 us due to the time constant of C8 and R1. When this occurs, the positive bias to the emitters of the PNP transistors in the digit counter is removed and all elements are turned off. Because of the width of the reset pulse, this condition remains long enough to allow the coupling capacitors between elements to become fully charged. Therefore, when the driver again goes into saturation and a positive bias is reapplied to the PNP transistors, no pulse transfer takes place and all elements remain deactivated. Capacitor C6 then charges negatively and eventually turns on Q2. The digit counter is restored to its original state and reset is accomplished.

(5) Resistor-Transistor Logic (RTL)

One of the basic networks used in switching circuitry is the resistor-transistor logic circuit (RTL). It is essentially a transistor switch with one or more controlling inputs. The transistor has two states of operation; fully cut off, or fully saturated. The condition of the transistor is determined by the inputs applied to the base circuit.

The circuit illustrated in figure 8 is initially biased so that transistor Q1 is cut off. When a negative signal is applied to any one of the inputs (A for example), it overcomes the cut-off bias and drives the transistor into saturation. The collector voltage of Q1 then drops from its high negative value to a low negative value. Since the inputs to this stage are negative-going pulses, the outputs are inverted or positive going pulses. The inverted output is indicated by a bar over the letter. Consequently, if signal A is applied to the input, $\bar{A}$ appears at the output. Since this circuit is triggered by any one or all of the inputs, the outputs become $\overline{A+B+C}$. When the circuit is operated under these conditions, it is commonly referred to as a negative "OR" gate or more simply a "NOR" gate. If the circuit is initially operated with all three inputs negative all three inputs must go positive to obtain an output. Under these circumstances the circuit becomes a "NAND" gate and its output is illustrated as $\overline{ABC}$.

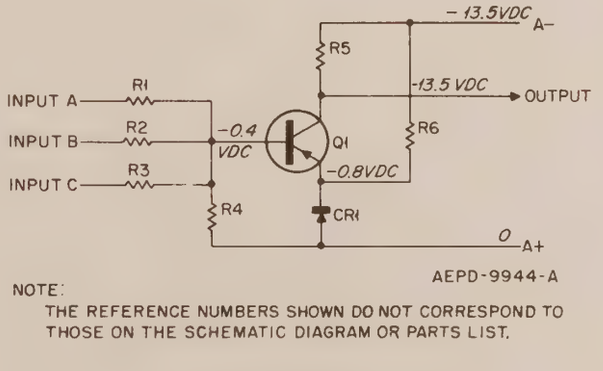


Figure 8.
RESISTOR-TRANSISTOR LOGIC CIRCUIT

(6) Schmitt Trigger

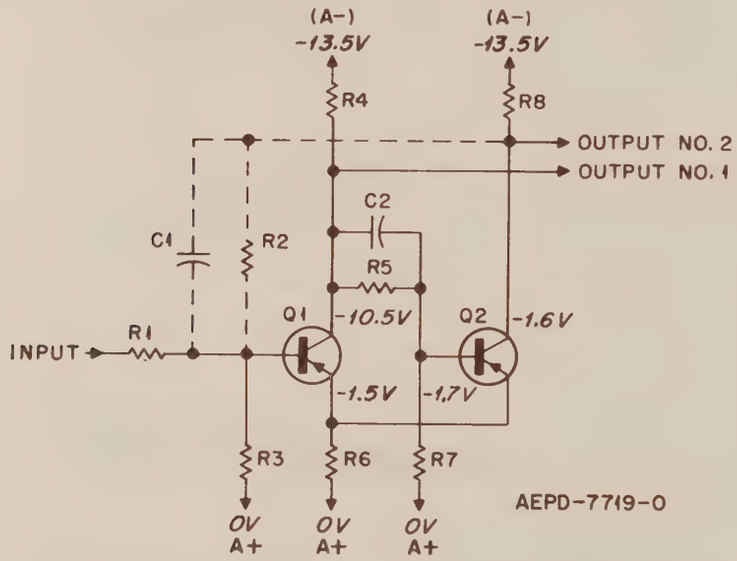
A Schmitt Trigger is a bistable circuit whose state depends on the amplitude of the input voltage. The output of the Schmitt trigger will be one value if the input exceeds a given level and the output will return to its initial value if the input goes below another level. The cir-

cuit may, therefore, be used for detecting a d-c level or squaring a sinusoidal or non-rectangular waveform.

Figure 9 shows the configuration of a typical Schmitt trigger network. With no input Q2 is biased into conduction. The common emitter voltage is then a function of the voltage divider formed by R6 and R8.

When the input drives the base of Q1 negative from 0 V to about -1.7 v, Q1 starts to conduct. Its collector goes positive and this positive transition is couple through C2 and R5 to the base of Q2, turning it off. With Q2 in the off condition, its base is somewhat more positive than it was when it was conducting. Therefore, the input must now be driven more positive than -1.7 volts to make Q2 conduct again.

R3 may be added to help cut off Q1. C1 and R2 may be added to help the rise time on output No. 1 when Q1 goes into conduction.



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Figure 9.
SCHMITT TRIGGER CIRCUIT

6. CIRCUIT DESCRIPTION

Refer to Schematic Diagram 63E81021A27 while following the operation described here.

a. Amplifier and Clipper

The amplifier and clipper (Q1 and Q2) is a difference amplifier which amplifies and limits the input signal from the radio receiver. Limiting, however, occurs only when the signal level exceeds 0.3 volt rms.

The audio output of the receiver is applied through transformer T1 to the base of Q1 and Q2. Two outputs of identical amplitude are developed across collector resistors R2 and R5. The outputs are coupled to the tone detectors.

b. Tone Detectors and Schmitt Triggers

The main purpose of the tone detector and Schmitt trigger circuits is to provide a change in the d-c output levels only while the proper tones are being received by the mobile. These tones are 2000 and 1800 cps in the automatic mode of operation and 1500 and 600 cps in the manual mode of operation. Each tone detector is coupled to the amplifier and clipper stage via an associated tone filter and impedance matching network. The tone filters are parallel tuned circuits. In the automatic mode, one circuit is tuned to 2000 cps (L1-C2) and the other to 1800 cps (L2-C7). The tuned circuits pass the tone signals to tone detectors Q5 and Q10 respectively. Except for the difference in the tuned frequency of each tone filter, operation of the tone detector circuits is identical.

When a 2000 cps tone signal appears at the output of the amplifier and clipper stage, it is coupled to the base of Q5 via its associated tone filter. Each positive-going half cycle of the tone signal causes the transistor to conduct. When this occurs, amplified pulses appear at the collector of Q5 and filter capacitor C4 rapidly charges to -12 volts. During the negative half cycle of each tone, the transistor is cut off and C4 attempts to discharge through load resistors R15 and R16. Since the time constant of the network is several times the transistor off period, there is very little capacitor discharge between half cycles. Therefore, while Q5 is receiving an input from its associated ton filter, its collector swings negative and remains in that condition for the duration of the tone.

The negative output from Q5 is fed to the Schmitt trigger circuit which consists of Q6 and Q7. The input of this circuit is sensitive to a d-c voltage level. Therefore, when the output of Q5 is fed to the base of Q6, the Schmitt trigger changes state. That is, Q6 is turned on and Q7 is turned off. When this occurs, a negative d-c level is developed and applied to various circuits throughout the supervisory unit.

When an 1800 cps tone is present at the output of the amplifier and clipper stage, it is coupled only to the base of Q10 and the operating sequence previously described is repeated. That is, Q10 begins to conduct, its associated Schmitt trigger changes state and again a negative d-c level is generated and fed to various circuits throughout the supervisory unit.

Tone detector operation in the automatic or manual mode of operation is the same except for the frequency of operation. In the manual mode, the tone detectors are set to receive 1500 cps (L1-C1-C2) and 600 cps (L2-C6-C7). The frequency of the tone filters is changed by transistors Q4 and Q9. The method for lowering the tuned frequency of the 1500/2000 cps tone filter is described in the following paragraph. The frequency of the 600/1800 cps tone filter is lowered in a similar manner.

When the manual mode of operation is selected at the control head, Q4 is driven into saturation by a positive signal from the Manual Control (W). When this occurs, C1 is tied to E- through the low saturation resistance of the transistor. This action parallels C1 and C2 which, in effect, increases the total capacitance across L1. Consequently, the tuned frequency of the tone filter is lowered from 2000 cps to 1500 cps. Similarly, Q9 shunts C6 across C7 to lower the frequency of the 600/1800 cps filter from 1800 cps to 600 cps.

Because of the lower tone frequencies employed in the manual mode of operation, a lower matching impedance is required between each tone detector and the amplifier and clipper stage. Transistors Q3 and Q8 are used specifically to satisfy this requirement. When turned on by the positive signal from the Manual Control (W), the low saturation resistance of each transistor effectively short circuits its associated resistor. As a result, the total impedance of the matching network is reduced to a lower value.

c. Channel Latch Control Circuit

The channel latch control circuit controls the searching action. It consists of gate circuits Q73, Q74, and Q78, integrator Q75, Schmitt trigger Q76 and Q77, and search driver Q79. In the automatic mode of operation, with no input applied to the circuit, Q74, Q75, Q77 and Q79 are in saturation. The mobile is unlatched and the search for the new marked idle channel is in progress.

The channel latch control circuit generates a negative signal to lock the mobile on channel whenever 120 ms of idle tone is continuously received by the mobile. Once locked on channel, the mobile is held in a latched condition by the receipt of idle or seize tone. Whenever a code mismatch occurs or the idle or seize tone is not received for 160 ms, the mobile is then unlatched to search for the new marked idle channel.

This occurs, however, only if the mobile is not in a transmit condition. In the manual mode of operation, channel searching is inhibited. Channel selection is performed manually by depressing the appropriate button on the control head.

When idle tone is received by the mobile, a negative signal is fed from the idle tone Schmitt trigger ($\overline{F'_i}$) to the base of Q73 via R199. This turns on Q73 and the positive signal derived from its output is directly coupled to the base of Q75 driving it into cut-off. The collector of Q75 then slowly goes negative as C73 and C78 commence to charge. Due to the time constant of the network, idle tone must be continuously received for 120 ms for the collector voltage of Q75 to become sufficient to forward bias the base-emitter junction of Q76. When this occurs, the Schmitt trigger becomes activated and a negative signal is fed from the collector of Q77 to the base of Q78, driving it into saturation. This causes Q79 to go into cut-off and the negative signal appearing at its collector is applied to the mobile and to the base of Q74 via R203 and CR58. Consequently, the mobile is locked on channel and Q74 is held in saturation. The receipt of idle or seize tone now keeps the mobile locked on channel.

Once the mobile is locked on channel, if idle or seize tone is not received, Q73 returns to its original cut-off condition. This drives Q75 into saturation and its collector slowly goes positive. Due to the time constant of the network, the Schmitt trigger remains activated for an additional 190 ms. If idle or seize tone is not received during this time interval, the Schmitt trigger reverts to its original state and Q79 goes into saturation. The mobile is then unlatched and the search for the new marked idle channel commences unless a signal from the transmitter keyer (U) is present. This signal is fed to the base of Q79 via CR50, CR67, CR68 and R359 and it holds the search driver in cut-off. Therefore, while the mobile is in the transmit condition, it is held on channel.

Whenever the mobile is locked on channel and a wrong number is received for any of the digits in its calling code (mismatch condition), the 50 ms timer is activated. A positive signal is then applied from the timer (M) to the base of Q74. Since Q74 is in saturation while the mobile is locked on channel, it is driven into cut-off. As a result, the collector of Q74 goes negative, diodes CR60 and CR61 become forward biased, and C73 and C78 rapidly discharge through R211, Q75, CR63, CR61, CR60 and R205. When this occurs, the collector of Q75 goes positive causing the Schmitt trigger to revert to its initial state. This drives Q79 into saturation and the mobile is unlatched to search for the new marked idle channel.

While the mobile is in the search condition, with no seize tone present a negative signal is applied rom the seize tone Schmitt trigger (F_s) to the base of Q74. This signal overrides the positive signal applied from the collector of Q79 to the cathode of CR58. As a result, Q74 is driven into saturation and its collector goes positive causing diodes CR60 and CR61 to become back biased. If seize tone appears on the channel before 120 ms of idle tone is received by the mobile, the seize tone Schmitt trigger changes state and a positive signal is applied to the base of Q74. This drives Q74 into cut-off and, in the manner previously described, C73 and C78 rapidly discharge through R211, Q75, CR63, CR61, CR60 and R205. The circuit returns to its original state and the mobile continues its search for the marked idle channel.

d. Detector Bistable

The detector bistable is a multivibrator circuit which consists of Q13 and Q14. In the automatic mode of operation, it generates a positive pulse for each frequency shift from seize to idle tone. If the mobile is locked on channel, this pulse is fed to the pulse counter and interdigit timer. When the mobile is not locked on channel, all pulses from the output of the detector bistable are inhibited.

In the manual mode of operation, the detector bistable generates a positive pulse for each frequency shift from 600 to 1500 cps or vice versa As in the automatic mode of operation, this pulse is also fed to the pulse counter and interdigit timer.

In the automatic mode of operation, each time idle or seize tone is detected, a negative signal is fed to the detector bistable. The signal is applied to the base of Q13 from the idle tone Schmitt trigger and to the base of Q14 from the seize tone Schmitt trigger. When this occurs the detector bistable changes state and generates a pulse. If the mobile is locked on an idle channel, the positive pulses developed at the collector of Q13 are fed to the pulse counter and interdigit timer through C12 and CR3. The pulses at the collector of Q14 are inhibited from the pulse counter and interdigit timer by CR2. Diode CR2 is normally reverse biased by a negative signal from the manual control (W) through R44.

When the mobile is not locked on channel, a negative signal is applied from the channel latch control circuit to CR4. This causes CR3 to become back biased. Therefore, all pulses from the detector bistable to the pulse counter and interdigit timer are inhibited.

In the manual mode of operation, the negative signal from the manual control to the anode of CR2 is removed. Both CR2 and CR3 are now in a forward biased condition. As a result, the detector bistable changes state and feeds a positive pulse to the pulse counter and interdigit timer when either a 600 or 1500 cps tone is received. The detector bistable receives a negative input signal from the idle tone Schmitt trigger when a 1500 cps tone is detected and a negative input signal from the seize tone Schmitt trigger when a 600 cps tone is received. Because of the polarity of diodes CR2 and CR3, the negative pulses generated by the detector bistable are blocked from the pulse counter and interdigit timer.

e. Selector Input Gates

The circuitry comprising the selector input gates receives all of the inputs from the various controlling circuits in the supervisory unit and applies them to the pulse and digit counters in order that the counters will be stepped, or reset as required.

The pulses received from the detector bistable or the identifier astable ($\overline{S}$) respectively, cause the pulse counter to step when the unit is receiving coding and when the unit is identifying. The pulse counter is reset when a positive pulse is received from the activity checker (J) or from the interdigit timer ($\overline{K}$). The former resets the counter just prior to signalling and identification and the latter resets the counter between digits. A negative inhibit signal is applied from the identifier bistable ($\overline{Q}$) to the selector input gate circuit to prevent the detector bistable from stepping the counter during identification.

An input is applied to the gate circuit from the interdigit timer ($\overline{K}$) to cause the digit counter to step to the next element. Inputs are received from the activity checker, the hook bistable or the channel latch control to reset the digit counter. The input from the activity checker (J) resets the digit counter just prior to signalling and identification. The input from the hook bistable ($\overline{P}$) resets the digit counter when the subscriber goes "on-hook". The input from the channel latch control ⑧ resets the digit counter when the mobile is directed to search. In addition the activity checker (J) input is inhibited by the identifier bistable ($\overline{Q}$) while the unit is identifying or by the selector inverter ($\overline{G}$) after the unit has correctly identified or received a call.

After the digit counter has been stepped to its last element, an output from the selector inverter ($\overline{G}$) is coupled to the selector input gates to inhibit further inputs from the interdigit timer ($\overline{K}$). This input is in turn inhibited by an input from the manual control (W) during manual operation.

The selector input gate circuit receives the inputs from the detector bistable during signalling and from the identifier astable during identification to step the pulse counter. An input is received from the interdigit timer between digits to step the digit counter. Other inputs are received from the interdigit timer and activity checker to reset the pulse counter and from the activity checker, the hook bistable and the channel latch control to reset the digit counter.

f. Pulse Counter

The pulse counter consists of a drive amplifier (Q24), reset element (Q25) and a nine element ring counter. Normally, the drive amplifier and reset element are in saturation.

The pulse counter counts the positive pulses generated by the detector bistable and identifier astable. Pulses from the detector bistable are counted during receipt of the coded calling signals from the base station. Identifier astable pulses are counted during mobile identification. The pulse count in each application is compared to a code preset in the digit counter. If a code match occurs, a positive signal is fed from the pulse counter to the interdigit timer and digit counter. If a mismatch exists, a negative signal is applied to these stages. After this occurs the pulse counter receives a reset pulse from the interdigit timer. The counter is then returned to its initial state in preparation to count the next train of pulses from the detector bistable or identifier astable.

Assume that the mobile's calling code is 3134786. When the first digit (3) is received from the base station, the detector bistable develops three positive pulses. These pulses are applied through C24 and CR13 to the base of the drive amplifier (Q24) and through C25 and CR14 to the base of the reset element (Q25). In addition, the same pulses are also applied to the interdigit timer via CR6. Each pulse to the pulse counter causes it to step to the next element in its complement. Therefore, when the first digit is received, the pulse counter steps until the third element is activated. Since the digit jumper lead from the first element in the digit counter is connected to the third element of the pulse counter, a code match occurs. The positive signal developed at the output of the activated element is then applied to CR20 via R123 and to the interdigit timer via C42, CR21, and CR45. Diode CR20 becomes forward biased. When the interdigit timer relaxes at the end of the first digit pulse train, it generates a positive pulse which is coupled to the pulse and digit counters. This pulse is fed to the pulse counter via C38 and CR17 and it is returned to its original state in preparation to receive the next digit from the base station. The digit counter receives its pulse via C40 and CR39 and is stepped to the next element in its complement. This occurs, however, only when a code match exists between the pulse and digit counters.

When the next digit (1) is received, the pulse counter advances to the first element. Again a match occurs and a positive signal is applied to CR22 via R127 and to the interdigit timer via C44, CR23 and CR45. Diode CR22 becomes forward biased. The interdigit timer relaxes and, as before, the pulse counter is reset and the digit counter is stepped to the next element. A similar procedure occurs when the remaining digits in the code are correctly received.

When a wrong number is received for any of the digits in the code a mismatch will occur. Assume that a number four (4 pulses) is received for the second digit. When this occurs, the pulse counter advances to the fourth element. A mismatch condition now exists and CR22 remains back biased by the negative output signal from the first element in the pulse counter. (Pulse counter element #4 is positive.) Therefore, when the interdigit timer relaxes, both the pulse and digit counter are reset. A positive pulse is then applied from the reset element

in the digit counter to the mismatch gate. This permits the mismatch gate output to trigger the 50 ms timer which, in turn, activates the channel latch control circuit and the mobile is unlatched to search for the new marked idle channel.

For transmission of the mobile identification code, pulses are applied from the identifier astable to the pulse counter via C37 and CR16. Each pulse to the pulse counter causes it to step to the next element in its complement. This action continues until a code match occurs between the pulse and digit counters. When this condition exists, the positive pulse developed at the output of the activated element is fed to the interdigit timer and digit counter. This pulse triggers the timer and turns off the identifier astable for the interdigit timers period of operation. At the end of this time interval (190 ms), the timer relaxes. Consequently, the pulse counter is reset, the identifier astable is turned on, and the digit counter is stepped to the next element in its complement. After the last digit of the identification code is transmitted, the seventh element of the digit counter is turned on, the identifier bistable is reset, clamping the identifier astable in the off condition and mobile identification ceases.

g. Digit Counter

The digit counter consists of a drive amplifier (Q44), reset element (Q45) and a seven element ring counter. Normally, the coupling diode between each digit counter element is back biased by negative signals from the pulse counter and the drive amplifier and reset element are in saturation.

The digit counter counts the number of digits transmitted during mobile identification and correctly received during mobile calling. A seven digit calling and identification code (established by jumper wires) is preset into the digit counter. This code is compared with the number of pulses counted by the pulse counter during either mobile calling or identification. When the correct number of pulses is counted, a code match occurs and the coupling diode associated with the activated element is forward biased by a positive signal from the pulse counter. In addition, the code match pulse is applied to the interdigit timer turning it on. When the interdigit timer relaxes, after a code match condition, the digit counter is stepped to the next element in its complement. When a mismatch occurs, the coupling diode associated with the activated element is reverse biased and the digit counter is reset by the interdigit timer.

After the seventh element of the digit counter is turned on, a positive signal is applied to the selector inverter and hook inhibit gate. The selector inverter prevents the interdigit timer from resetting the digit counter during receipt of the ringing signals. The hook inhibit gate is turned off to enable the subscriber to successfully go "off-hook" in answer to an incoming call.

As previously described, 190 ms after the first code digit is received by the mobile, the interdigit timer relaxes and feeds a positive pulse to the digit counter. This pulse is coupled to the base of Q44 via C40 and CR39 and to the base of Q45 via C56 and CR42. Consequently, Q44 is cut off and a negative signal appears at its collector. This signal is then applied through R113 to the common emitters of the PNP transistors in the digit counter and all elements are turned off.

When this occurs, a negative pulse is derived from the output of Q45. If after receipt of the first code digit, a code match occurs between the pulse and digit counter, CR20 becomes forward biased by a positive signal from the pulse counter. Consequently, the negative pulse from the output of Q45 is coupled to the base of Q47 via CR20 and C43.

Transistor Q47 remains cut off, however, since its emitter is biased negative by the signal from the collector of Q44. When the positive pulse at the base of Q44 is removed and it again saturates, a positive signal is reapplied to the common emitters and Q47 is then turned on. Because of this action Q46 is also turned on and the first element transistor pair remains locked in saturation. For a brief interval after this occurs, the pulse from the interdigit timer to the base of Q45 keeps it turned off. During this time, C41 charges (positive) through R117 and the low saturation resistance of Q46. When the pulse at the base of Q45 is removed, the positive charge on C41 continues to hold it in cut off provided any one element in the ring counter is activated.

After the second digit of the code is received, a similar procedure occurs. The interdigit timer relaxes and couples a positive pulse to the drive amplifier and reset element. This causes the drive amplifier to go into cut off and, as previously described, the negative signal at its collector is fed to the common emitters of the PNP

transistors in the digit counter. Again, if a code match occurs, a negative pulse is fed from the first element through CR22 and C45 to the second element and it is turned on.

Assume that the third digit of the code is three (3) and a four (4 pulses) is received for the third digit. When this mismatch condition exists, CR24 remains in its initial reverse biased condition. Therefore, when the interdigit timer relaxes and the elements in the ring counter are cut off, CR24 inhibits the negative pulse developed at the output of the second element. This prevents the third element from being turned on, C41 charges (negative) and turns on Q45 and the digit counter is reset.

After correctly receiving all seven digits of its calling code (match occurs for each digit received), the seventh element of the digit counter is turned on. When this occurs, a positive signal is applied to the selector inverter and hook inhibit gate. The selector inverter, in turn, feeds a negative signal to the anode of CR39 and it becomes reverse biased. This prevents the interdigit timer from resetting the digit counter should it become activated after the seventh element is turned on (i.e., during ringing).

h. Interdigit Timer

The interdigit timer consists of a pulse amplifier (Q19), integrator (Q20), and Schmitt trigger (Q21 and Q22). With no signal applied to the circuit, Q19 and Q22 are in saturation.

The interdigit timer becomes activated by a positive pulse from either the detector bistable or digit counter. Positive pulses are applied from the detector bistable during receipt of the coded calling signals from the base station. The digit counter turns on the timer during transmission of the mobile identification code. When the timer becomes activated, it generates a positive and negative signal. During mobile identification, the positive signal turns off the identifier astable for approximately 190 ms. This establishes the time between the transmission of each digit in the mobile identification code. The negative signal activates the ringer control circuit after receipt of the last digit in its code.

After the interdigit timer's period of operation (190 ms), it returns to its original state and another positive and negative signal are generated. The positive signal is used to reset the pulse counter; step the digit counter to the next element in its complement if a code match exists (resets the digit counter if a mismatch occurs) and to activate the mismatch gate. The negative signal is applied to the identifier astable to initiate the transmission of the next digit in the mobile identification code.

Positive pulses from the detector bistable are coupled through CR6 to the base of Q19. These pulses cut off the pulse ampifier making its collector momentarily negative. The resulting negative pulse at the collector of Q19 is directly coupled to the base of integrator Q20. As a result, the emitter of Q20 goes negative, C17 quickly charges and the Schmitt trigger is then turned on.

While pulses are being received from the detector bistable, capacitor C17 remains charged and the Schmitt trigger is held in the activated condition. When pulsing is interrupted between digits, Q19 again saturates and the base of Q20 goes positive causing it to cut off. Capacitor C17 then begins to slowly discharge. Approximately 190 ms after receiving the last pulse in the code digit pulse tran, the negative charge on C17 is reduced to a level sufficient to back bias the base-emitter junction of Q21. The Schmitt trigger then changes state and the positive pulse developed at the collector of Q22 is fed to the mismatch gate and to the pulse and digit counters.

When a code match occurs between the pulse and digit counters during mobile identification, a positive pulse is applied from the digit counter to the base of Q19 via CR9 and C18. In the manner previously described, the interdigit timer is turned on and the sequence outlined above is repeated. In this application, however, the positive signal to the identifier astable holds it in cut off for approximately 190 ms. This provides the interdigit time during transmission of the mobile identification code.

While the mobile is transmitting the disconnect signal, the digit counter is prevented from activating the interdigit timer. A negative signal is applied from the 750 ms timer through R62 to the anode of CR9 and it becomes back biased. Therefore, during the transmission of the disconnect signal, the digit counter is inhibited from triggering the interdigit timer.

i. Mismatch Gate

The mismatch gate (Q23) turns on the 50 ms timer whenever a code mismatch occurs between the pulse and digit counters. Normally, it is in

saturation and when activated by the interdigit timer it generates a positive pulse. This pulse is inhibited when a match condition exists. When a mismatch occurs, the pulse is applied to the 50 ms timer which, in turn, unlocks the channel latch control circuit and the mobile commences to search for the marked idle channel.

When the interdigit timer relaxes, a positive pulse is coupled through C20 to the base of Q23. Because of the time constant of C20 and R70, Q23 is turned on for approximately 2 ms. At the end of this time interval, Q23 again goes into saturation and a positive pulse is generated and fed to C21. If a match condition exists, the digit counter steps to the next element in its complement and a negative signal is fed from the digit counter reset element to C21 via R72. This prevents C21 from charging and inhibits the pulse transfer from Q23. If a mismatch condition exists and the digit counter is reset, the pulse from Q23 is coupled to the 50 ms timer. This triggers the timer which, in turn unlocks the channel latch control circuit and the mobile is unlatched to search for the marked idle channel.

j. Selector Inverter

The selector inverter consists of pulse inverters Q60 and Q61. When activated by the digit counter, it generates two signals of opposite polarity (G and $\overline{G}$). The negative signal ($\overline{G}$) is applied to the oscillator #1 and oscillator #2 control gates, the selector input gate, hook reset gate, and the identifier bistable. The positive signal (G) is fed to the handset control, the 750 ms timer, the hook inhibit gate, and the ringer control.

After the mobile has correctly received all seven digits of its calling code, a positive signal is fed from the last element in the digit counter to the base of Q60. Since transistor Q60 is normally in saturation, it is turned off and Q61 is turned on. When this occurs, a positive and negative signal are generated. The negative signal ($\overline{G}$) is derived from the collector of Q60; the positive signal (G) from the collector of Q61. These signals are then fed from the inverter to the various circuits mentioned previously.

k. 750 MS Timer

The 750 ms timer (Q80 and Q81) is a monostable multivibrator which initiates the transmission of the acknowledge or disconnect signal. With no input to the circuit, Q80 is in saturation and Q81 is in cut off.

After the mobile has correctly received all seven digits of its calling code, a positive pulse is applied from the selector inverter (G) to the base of Q80 via R224, C61 and CR53. When this occurs, the monostable changes state. That is, Q80 is turned off and Q81 is turned on. A negative signal ($\overline{T}$) generated at the collector of Q80 and Q81 is fed to the transmitter keyer. At the same time, a positive signal (T') is generated at the collector of Q81 and is fed to the oscillator #1 control gate. Consequently, the acknowledge signal is transmitted. At the end of 750 ms, the timer returns to its original state. The negative signal is removed from the transmitter keyer and the positive signal is removed from the oscillator #1 control gate. Consequently, the acknowledge signal ceases.

When the mobile goes "on-hook", a positive pulse ($\overline{P}$) is generated by the hook bistable and applied to the base of Q80 via R244, C115 and CR54. The timer then becomes activated and a positive signal is coupled to the identifier bistable to inhibit the negative signal (P) from the hook bistable. At the same time, a negative signal is coupled to the base of Q93 in the identifier bistable and to the base of Q97 in the parity bistable. Because of these signals, the identifier bistable changes state and the parity bistable is clamped. The identifier astable is now unclamped, oscillates and initiates the disconnect pulses. A negative signal is also sent to the digit counter input to the interdigit timer to prevent triggering of the interdigit timer during disconnect.

While the mobile is "off-hook", timer operation in inhibited. This is accomplished as follows:

When the handset is removed from its holder, a negative signal is applied from the hookswitch contacts (7) to CR54 via R269 and R263 and it becomes back biased. If the hook bistable is triggered by the action of going "off-hook" and then the call attempt is blocked, a positive pulse is applied from the hook bistable ($\overline{P}$) to CR54 via R244 and C115. This pulse, however, is inhibited from the base of Q80 by CR54 which, as previously mentioned, is back biased. Therefore, timer operation is prevented.

Similarly, when the mobile successfully goes "off-hook", CR53 receives a negative signal from the hook bistable ($\overline{P}$) via R223 and it also becomes reverse biased. Therefore, after the mobile has identified, the positive pulse from the selector inverter (G) to the base of Q80 is inhibited. In this manner, the 750 ms timer is prevented from

n. Hook Inhibit Gate

The hook inhibit gate controls the triggering of the hook bistable. It is essentially a six input diode gate (CR88). If the polarity of the inputs are such that CR88 becomes reverse biased, the gate is turned off and the subscriber is prevented from successfully going "off-hook" (triggering hook bistable). When CR88 becomes forward biased, the gate is turned on and the action of going "off-hook" triggers the hook bistable. The off condition exists while the mobile is searching for the marked idle channel or receiving signalling. The gate is turned on when the handset is removed from its holder in answer to an incoming call and while the mobile is resting on an idle channel. In the manual mode of operation, except for a brief interval after going "off-hook", the gate is held in the on condition.

When the 750 ms timer is activated to initiate the transmission of the acknowledge or disconnect signal, a negative signal is applied from the timer ($\overline{T}$) to the anode of CR88. This signal is applied via CR84 and R240 and it back biases the diode. Therefore, when the handset is removed from its holder, the pulse from the hook switch Schmitt trigger to the hook bistable is inhibited. As a result, the subscriber is prevented from initiating a call while either the acknowledge or disconnect signal is being transmitted.

While the mobile is searching for an idle channel, a negative signal is fed from the channel latch control circuit (N) to the gate via CR85. This turns off the gate blocking any attempt to initiate a call during the searching action.

During the receipt of signalling from the base station, the activity checker is turned on. When this occurs, the diode gate receives a negative input ($\overline{J}$) through R240, R275, R274 and CR86 and it becomes back biased. Therefore, while signalling is being received from the base station the action of going "off-hook" is inhibited.

While the mobile is resting on an idle channel, a positive input (F_i) is applied from the idle tone Schmitt trigger to the gate via R273, R274, R275 and R240. Consequently, the on condition exists and the hook bistable is triggered when the handset is removed from its holder.

After the mobile has correctly received all seven digits of its calling code, the selector inverter (G) supplies a positive signal to the diode gate via CR89, R275 and R240. This input overrides the negative signal from the activity checker and the gate is turned on. This enables the subscriber to successfully go "off-hook" in answer to an incoming call while ringing signals are being received from the base station.

When the manual mode of operation is selected at the control head, a positive signal is fed from the manual control (W) to the anode of CR88 via CR126. This signal keeps the gate in the on condition while the mobile is operating in the manual mode. Therefore, except for brief interval after going "off-hook", whenever the push-to-talk button ⑨ is pressed the hook bistable is triggered.

When the handset is removed from its holder in the manual mode of operation, a negative pulse is applied from the hook switch contacts ⑨ to CR88 via C117, CR127 and R240. Due to the short duration of the pulse, the gate is momentarily turned off and the handset push-to-talk function is temporarily inhibited. That is, the hook bistable does not become activated when the push-to-talk button is pressed. This prevents the transmitter from being keyed if the push-to-talk button is accidentally pressed while going "off-hook".

When the mode of operation is switched from manual to automatic, the polarity of the signal from the manual control (W) to the hook inhibit gate changes from positive to negative. This negative-going short duration pulse is fed to the anode of CR88 via C95 and CR125 and the gate is momentarily turned off. If the handset is "off-hook" when the mode of operation is switched, the positive pulse developed by the hook switch Schmitt trigger is prevented from activating the hook bistable. To successfully go "off-hook", the handset must be returned and then removed from its holder.

o. Hook Bistable

The hook bistable (Q84 and Q85) is a bistable multivibrator circuit. When triggered by a positive pulse from the hook switch Schmitt trigger, it generates positive (P) and negative ($\overline{P}$) output signals. These outputs are applied to various circuits throughout the unit to initiate the off-hook condition. The hook bistable is returned to its initial state when the mobile goes "on-hook" and when a call attempt is blocked. Initially ("on-hook" condition), Q84 is in saturation and Q85 is in cut-off.

being activated while the handset is out of its holder.

In the manual mode of operation, the 750 ms timer is disabled. A positive signal is fed from the manual control (W) to the collector of Q80 via CR52. This clamps the collector to a positive value and as a result, timer operation is inhibited.

l. Ringer Control

The ringer control (Q62 and Q63) operates the control head ringer. With no input applied to the circuit, Q62 and Q63 are biased into cut-off.

In the automatic mode of operation, after the mobile correctly receives its calling code, the selector inverter becomes activated and feeds a positive signal to the emitter of Q62. This primes the ringer control circuit for operation. That is, the ringing signals are now ready to be received.

With the receipt of the ringing signals, the interdigit timer becomes activated and a negative signal ($\overline{K}$) is applied through R161 and R160 to the base of Q62. This drives Q62 into saturation and the positive signal appearing at its collector is directly coupled to the base of Q63 driving it into saturation. Consequently, the emitter of Q63 goes positive. This positive signal is then fed to the control head ringer and it becomes activated.

When the mobile goes "off-hook" in answer to an incoming call, the positive signal generated by the hook bistable (P) is fed to the base of Q62 via CR34 driving it into cut-off. The negative signal developed at its output then turns off Q63 and mobile ringing ceases.

If the incoming call is left unanswered for 45 seconds, the base station removes seize tone from the channel. The channel latch control becomes unlatched and resets the digit counter. When this occurs, the positive signal from the selector inverter to the emitter of Q62 is removed. The ringer control then returns to its initial state and mobile ringing ceases.

In the manual mode of operation, the control head ringer becomes activated immediately after the mobile receives all seven digits of its calling code. A negative signal is fed from the control head (6) to the base of Q62 via CR124, R160 and R162. This signal prepares Q62 for operation. When the mobile receives its calling code, the selector inverter is turned on and a positive signal is fed to the emitter of Q62. Since the base of Q62 is biased negative by the signal from the control head (6), it is also turned on. This drive Q62 into saturation and the positive signal appearing at its emitter causes the mobile ringer to operate. The mobile ringer then operates continuously until the mobile goes "off-hook" in answer to the call or until the digit counter is reset by a clearing pulse from the base station. When this occurs, the ringer is de-activated as previously described in the automatic mode of operation.

m. Hook Switch Schmitt Trigger

The hook switch Schmitt trigger (Q82 and Q83) generates a positive pulse to trigger the hook bistable. Removing the handset (7) from its holder activates the Schmitt trigger in the automatic mode of operation. In the manual mode of operation, except for a brief interval after going "off-hook", the Schmitt trigger is turned on each time the handset push-to-talk button is pressed. With no input to the circuit, Q82 is biased into saturation and Q83 is biased into cut-off.

When the handset is removed from its holder (automatic mode) or when the handset push-to-talk button is pressed (manual mode), a set of switch contacts are closed. When this occurs, a negative potential is applied through R361 to the junction of C114 and R232 and C114 begins to charge. When the charge on C114 is sufficient to forward bias the base-emitter junction of Q83, the Schmitt trigger changes state. The result is that a positive signal is generated at the collector of Q83 and applied to the hook inhibit gate via C69.

The network consisting of R361 and C114 serves two functions. Primarily it damps out the pulsating voltage generated by the contact bounce when the hook switch or push-to-talk contacts are closed. This prevents the Schmitt trigger from alternately being turned on and off. Secondly, it momentarily prevents the Schmitt trigger from being turned on after going "off-hook". In the manual mode of operation, this delay permits the hook inhibit gate to temporarily inhibit the handset push-to-talk funtion only after the mobile initially goes "off-hook". This feature prevents the transmitter from being accidentally turned on should the push-to-talk button be depressed while going "off-hook".

When the mobile is resting on an idle channel and the handset is "on-hook" signals from the idle tone Schmitt trigger (Fi which is positive and $\overline{Fi}$ which is negative) are applied to the hook reset gate. $\overline{M}$ and $\overline{L}$ signals come respectively, from the 50 ms 350 ms timer and go negative when the timers are activated.

Assume that a mobile subscriber has gone "off-hook" to initiate a call but the channel has been seized by another mobile. Idle tone will be removed by the base station during the initial 350 ms period. The idle tone Schmitt trigger changes state and a positive voltage is fed to R371 via $\overline{Fi}$ which removes the reverse bias from CR95. When the 350 ms timer relaxes, $\overline{L}$ goes positive A pulse is coupled through C103, CR95, C118 and CR65 to the base of Q85 to reset the hook bistable and the call attempt is blocked. If the transmission of connect tone is completed after coming "off-hook", the 50 ms timer relaxes and $\overline{M}$ will go positive. If idle tone has not been removed from the channel during the transmission of connect tone (tone not received by the base station), Fi remains positive and when M goes positive, a positive pulse is fed through C120, CR96, C118 and CR65 to the base of Q85. This resets the hook bistable and again blocks the call attempt.

In a successful call attempt, when the mobile subscriber goes "off-hook", the 350 ms timer is triggered. When the timer relaxes, $\overline{L}$ goes positive. However, CR95 is back-biased since idle tone is still being received and $\overline{Fi}$ is still negative. When the 50 ms timer is triggered, connect tone is transmitted by the mobile for the same interval. The base station, upon receipt of connect tone, then removes idle tone. The idle tone Schmitt trigger changes state, Fi goes negative and CR96 is reverse-biased. When the 50 ms interval is over, $\overline{M}$ goes positive but CR96 blocks the resulting positive pulse.

Whenever a call has been received by the mobile or when the mobile has finished its identification, $\overline{G}$ will go negative which reverse biases CR65 via R367. This disables the reset gate.

The circuit consisting of CR66, R250, R251 and C75 is provided to reset the hook-bistable when going from manual to the automatic mode. When going from manual to automatic, ⑥ goes positive. A pulse is coupled through CR66 and resets the hook-bistable. This insures that, if a mobile subscriber is in the manual mode with the push-to-talk button depressed, and inadvertently goes to the automatic mode, the mobile transmitter will not remain on.

CR97 prevents the reset of the hook-bistable during conversation in the manual mode, CR96 is back-biased through R369 and CR97 to ⑥ which is negative in the manual mode. If the voice frequencies contain components that pull in the 1500 cps tone detector, pulses are generated that drive the pulse counter. When a mismatch is detected, the mismatch gate generates a pulse which triggers the 50 ms timer. This could reset the hook-bistable if CR96 were not reverse-biased.

s. 350 MS Timer

The 350 ms timer (Q87 and Q88) is a monostable multivibrator circuit. With no input to the circuit, Q87 is biased into cut-off and Q88 is biased into saturation.

In the automatic mode of operation, the 350 ms timer becomes activated by a positive pulse from the hook bistable each time the mobile successfully goes "off-hook". When activated, it inhibits operation of the 750 ms timer and identifier bistable. In addition, when the handset is removed to answer a call, it turns on the oscillator #2 control gate to initiate the transmission of connect tone. When the mobile successfully goes "off-hook" to originate a call, it delays the transmission of connect tone for the period of its operation (350 ms). When the timer relaxes after being activated, it returns to its original state and feeds a positive pulse to the 50 ms timer.

When the hook bistable is triggered by the action of going "off-hook", a positive pulse (P) is fed to the base of Q88 via C104 and CR71. As a result, Q88 is turned off and Q87 is turned on. The negative signal appearing at the collector of

When the mobile goes "off-hook", the positive pulse developed by the hook switch Schmitt trigger is applied to the hook inhibit gate via C69. If the gate is on, the pulse appears at the base of Q84. Consequently, Q84 is turned off and its output ($\overline{P}$) goes negative; Q85 is turned on and its output (P) goes positive. The positive output turns on the 350 ms timer, primes the identifier bistable and handset control circuits and turns off the ringer control. The negative output turns on the transmitter keyer and turns off the frequency switching transistor (Q104).

When the handset is returned to its holder, the hook bistable reverts to its "on-hook" condition. The action of going "on-hook" causes the hook switch Schmitt trigger to change state. A negative signal is then applied to the base of Q84 via R239 which causes Q84 to turn on and Q85 to turn off.

When a call attempt is blocked, the hook reset gate feeds a positive pulse to the base of Q85. This drives Q85 into cut-off and the hook bistable is returned to its "on-hook" condition.

p. Transmitter Keyer

The transmitter keyer consists of a two input "NOR" gate (Q70) and a drive amplifier (Q71). When activated by the hook bistable or 750 ms timer, it generates a positive and negative signal. The positive inhibit signal is fed to the channel latch control circuit. The negative signal is applied to the transmitter-turn-on circuit the transmit lamp, the mixer gate and to the busy lamp driver.

Whenever the hook bistable ($\overline{P}$) or 750 ms timer ($\overline{T}$) becomes activated, a negative signal is applied to the base of Q70, turning it on. The positive signal developed at its collector (U) is then fed to the channel latch control circuit and to the base of Q71. As a result, the channel latch control circuit is clamped to prevent the mobile from searching while in the transmit condition and Q71 is driven into saturation. The negative signal appearing at the collector of Q71 is then fed to the mobile transmitter keyer, the transmit lamp, the mixer gate and the busy lamp driver. Thus, the mobile transmitter is turned on and the transmit lamp on the control head is illuminated.

q. Busy Lamp Driver

The busy lamp driver consists of transistor Q72 and associated circuitry. In the automatic mode of operation, it illuminates the busy lamp on the control head whenever the handset is removed from its holder and a busy condition exists i.e., the mobile is not locked on the idle channel, signalling is being transmitted and received by the mobile or the channel is seized by another mobile for the origination of a call. Two requirements must be satisfied to illuminate the BUSY lamp. The handset must be out if its holder and the transmitter keyer must be in its static state. Normally, Q72 is biased into cut-off.

The circuit from A+ through the busy lamp to the collector of Q72 constitutes the busy lamp circuit. The base and emitter of Q72 are connected to A- through the hook switch contacts on the control head. Therefore, when the handset is removed from its holder, the hook switch contacts are closed and A- is applied to the transistor. If the transmitter keyer does not become activated at the time of "off-hook", Q72 is biased into saturation. As a result, the collector of Q72 is tied to A- through the low saturation resistance of the transistor and the busy lamp becomes illuminated. If the transmitter keyer does become activated, a negative signal is applied to the junction of CR49 and CR51, driving the base of Q72 negative. This maintains the transistor in cut-off and the busy lamp is held off.

In the manual mode of operation, the emitter of Q72 is connected to A- through contacts on the handset push-to-talk switch. Therefore, when the button is pressed, A- is applied to the transistor. However, except for a brief interval after going off-hook, the transmitter keyer also becomes activated each time the button is pressed. Consequently, in the manual mode of operation, the busy lamp can only be lit if the handset button is depressed when going "off-hook".

r. Hook Reset Gate

The hook reset gate uses diode logic to restore the hook bistable to its original "on-hook" condition, and block an attempted call whenever the proper sequence of events has not occurred.

In the automatic mode, calls can be blocked in a number of ways. A subscriber who has gone "off-hook" to initiate a call should find his attempt blocked if another mobile has already seized the channel. A mobile originated call is also blocked if the base station fails to receive the mobiles transmission of connect tone. In the manual mode of operation, the hook reset gate is prevented from resetting the hook bistable.

nal inhibits the negative signal from Q98 and Q99 is cut off. Therefore, guard tone is cut off for 50 ms. At this time, connect tone is transmitted.

When the identifier bistable is triggered prior to the transmission of the mobile identification code, the identifier astable starts oscillating and a 25 ms pulse is generated every 50 ms. These pulses are simultaneously applied to one input of the gate and to the parity bistable. Each time an even numbered pulse from the identifier astable swings positive, the parity bistable changes state and feeds a positive signal to the gate. When this occurs, all the inputs to Q98 are positive and Q98 is turned off. The negative signal appearing at the collector of Q98 is then fed to the "NOR" gate via R307. This turns on the "NOR" gate and the positive signal derived from its output is applied to the emitter of the mixer gate for the transmission of guard tone. When the even numbered pulse from the identifier astable swings negative, Q98 is turned on and guard tone transmission ceases.

Whenever dial tone is received by the mobile and the control head dial is cocked for the dialing of a phone number digit, the previously mentioned off-normal dial contacts are closed. When this occurs, a positive signal (9) is applied to the base of Q98. This inhibits the negative signal from the 750 ms timer and Q98 is cut off. As a result, the mixer gate (Q102) is turned on and guard tone is transmitted as long as the dial is cocked.

When the control head dial is released, another set of dial contacts alternately opens and closes. Normally, these contacts are closed. In this condition, the negative voltage for the collector of Q98 is applied through these contacts. When they open, the collector voltage is removed from Q98 and consequently the base voltage from Q99 is removed and it is turned off. Thus, the transmission of guard tone is interrupted while the dial contacts are open.

In the manual mode of operation, a negative signal (6) from the auto/manual switch is applied to the base of Q98. This causes Q98 to saturate and guard tone is inhibited.

v. Oscillator #1

Oscillator #1 (Q100 and Q101) is a tuned oscillator with a frequency of oscillation of 2150 cps (guard tone). The oscillator is in operation at all times. Its output is fed to mixer stage Q102 via CR83 and R334. Normally, a positive signal is applied to the base of Q102 from the transmitter keyer. This back biases the base-emitter junction, inhibiting the oscillator output.

When the transmitter keyer is turned on, a negative signal is applied to the base of Q102 causing the audio tone signal generated by oscillator #1 to be fed to the mixer stage.

w. Oscillator #2 Control Gate

The oscillator #2 control gate (Q103) is a three input "NOR" gate. When a negative signal is applied from either the identifier astable ($\overline{S}$) the 350 ms timer ($\overline{L}$) or the 50 ms timer ($\overline{M}$), Q103 is driven into saturation and a positive signal appears at its collector. This signal is then applied to the emitter of the mixer (Q107) and the tone (connect or disconnect) from oscillator #2 is transmitted.

When the mobile comes "off-hook" in response to a call, the 350 ms timer ($\overline{L}$) and the 50 ms timer ($\overline{M}$) provide inputs to the gate for transmission of 400 ms of connect tone. When the mobile comes "off-hook" to initiate a call, a positive input from the selector inverter ($\overline{G}$) inhibits the 350 ms timer input. Consequently, only the 50 ms timer input initiates transmission of connect tone.

During identification, the identifier astable provides a negative input ($\overline{S}$) to initiate transmission of 25 ms bursts of connect tone. During disconnect, the same input will initiate transmission of 25 ms bursts of disconnect tone.

When the dial on the control head is released after being cocked to dial a phone number digit, a set of dial contacts alternately opens and closes as the dial wheel returns to rest. While the contacts are closed, a negative voltage is applied to CR120 and it is forward biased. When CR120 conducts, CR119 becomes reverse biased and the emitter voltage is removed from the mixer gate (Q107). When the dial contacts open, CR120 cuts off and CR119 is forward biased. This permits emitter current to flow in Q107 and connect tone is transmitted.

The oscillator #2 control gate controls the time when emitter current flows in the mixer associated with oscillator #2. When the mixer gate (Q107) conducts, oscillator #2 output is transmitted. When the mobile answers a call,

Q88 is then coupled to the 750 ms timer and to the identifier bistable. Three hundred and fifty (350) milliseconds after this occurs, the timer relaxes and returns to its original state. A positive pulse is then generated at the collector of Q88 and fed to the 50 ms timer.

In the manual mode of operation, the 350 ms timer does not function. A negative signal is fed from the control head ⑥ through R261 to the anode of CR71 back biasing it. Therefore, when the hook bistable is turned on, the pulse to the base of Q88 is inhibited and the timer remains in its stable condition.

t. 50 MS Timer

The 50 ms timer is a monostable multivibrator circuit consisting of Q89 and Q90. Normally (on hook condition), Q89 is in cut-off and Q90 is in saturation.

In the automatic mode of operation, the 50 ms timer becomes activated by the 350 ms timer during the off-hook condition and by the mismatch gate when a mismatch condition exists. When this occurs, a positive and negative signal are developed. The positive inhibit signal is applied to the channel latch control circuit, hook reset gate, and to the oscillator #1 control gate. The negative signal is fed to the oscillator #2 control gate for the transmission of 50 ms of connect tone.

In the manual mode of operation, the 50 ms timer does not function.

When the 350 ms timer relaxes after being triggered by the hook bistable, a positive pulse is fed to the base of Q90 via C80 and CR73. The 50 ms timer then changes state and the negative signal developed at the collector of Q90 ($\overline{M}$) is applied to hook reset gate and the oscillator #2 control gate for the transmission of connect tone. The positive inhibit signal generated at the collector of Q89 (M) is fed to the channel latch control circuit, and to the oscillator #1 control gate.

When a code mismatch occurs between the pulse and digit counter, a positive signal is fed from the mismatch gate (V) to the base of Q90 via CR74. The 50 ms timer changes state and preceding action is repeated.

In the manual mode of operation, a negative signal is applied from the control head ⑥ to the anode of CR73 via R267 and it becomes back biased. Consequenctly, all pulses from the 3[illegible] ms timer to the 50 ms timer are inhibited.

u. Oscillator #1 Control Gate

The oscillator #1 control gate controls the transmission of guard tone. It consists of two hybrid, three-input gates (Q98 and Q99). Normally, Q98 is cut off and Q99 is in saturation.

When Q99 is in saturation, the mixer gate associated with oscillator #1 is primed for conduction. This is done when the positive signal from the control gate is applied to the emitter of Q102. Q102 does not conduct, however, unless the transmitter keyer is activated. In the normal quiescent state, the inputs to the gate from the identifier astable ($\overline{S}$) and the parity bistable are positive. The signal applied from the 750 ms timer is negative but, until the mobile receives a call or identifies itself, it is inhibited by a positive signal ($\overline{G}$) from the selector invertor. At this time the dial off-normal contacts (9) are open. Therefore, because of the inputs, Q98 is cut off and Q99 consequently is conducting.

When the mobile receives a call, the selector inverter is turned on. The signal ($\overline{G}$) from the selector inverter goes negative and the input from the 750 ms timer is uninhibited. But, when ($\overline{G}$) goes negative the 750 ms timer input goes positive so the control gate does not change state. At this time, the transmitter keyer is actuated and the mixer is turned on to permit a 750 ms transmission of guard tone. At the end of the 750 ms period, the input from the timer goes negative, Q98 conducts, Q99 cuts off and the mixer (Q102) cuts off the guard tone. When the mobile goes "on-hook", after answering or completing a call, the selector inverter is reset and the input ($\overline{G}$) goes positive, so that the input from the 750 ms timer is again inhibited. At the same time, the identifier astable is unclamped and a negative signal ($\overline{S}$) is applied to the gate for 25 ms. This cuts off the guard tone. As the identifier astable oscillates, 25 ms bursts of guard tone will be transmitted every 50 ms. Because the identifier astable output ($\overline{S}$) is applied to oscillator #2 control gate, disconnect tone is transmitted while the guard tone is cut off.

When the mobile comes "off-hook" to initiate a call, the gate output to the mixer is positive. Consequently, guard tone is transmitted. Three hundred and fifty ms after "off-hook" the 50 ms timer is turned on and a positive signal (M) is applied to the collector of Q98. This sig[illegible]

ter junction of Q17, the Schmitt trigger changes state. That is, Q17 is turned on and Q18 is turned off. A positive reset pulse is then applied from the collector of Q17 to the pulse and digit counters. In addition, a negative inhibit signal is fed from the collector of Q18 to the hook inhibit gate.

After the removal of seize tone from the channel, Q16 returns to its initial cut off condition and C13 begins to slowly discharge. Due to the time constant of the network, the Schmitt trigger is held in the activated condition for an additional 190 ms after the removal of seize tone from the channel. This prevents the activity checker from dropping out and turning on the hook inhibit gate during the receipt of signalling from the base station. It also delays the start of identity out-pulsing for 190 ms after drop out of seize tone when the mobile is initiating a call.

In the manual mode of operation, the positive clamping signal from the manual switch (6) to the base of Q15 is removed. Therefore, when a 600 cps or 1500 cps tone is received by the mobile, negative signals are applied to the bases of Q16 and Q15 respectively, turning them on. This activates the Schmitt trigger in the manner previously described. As in the automatic mode of operation a positive reset pulse is applied to the pulse and digit counters.

aa. Dial Inhibit

The dial inhibit circuit consists of Q69 and associated circuitry. It inhibits operation of the pulsing contacts on the control head dial until the mobile identification code has been transmitted. Transistor Q69 is placed in shunt across the contacts and is normally held in saturation by a positive signal from the handset control circuit to its base. In this condition, the dial pulsing contacts are effectively short circuited by the low saturation resistance of the transistor and are disabled. After mobile identification is completed, the handset control circuit feeds a negative signal to the base of Q69 driving it into cut off. The short circuit across the contacts is removed and the contacts convert the dialed number of the called party into pulses.

ab. Handset Control Circuit

The handset control circuit consists of two "NOR" gates (Q65 and Q66) and two transistor switches (Q67 and Q68). It is used to control handset muting. In the automatic mode of operation, the handset becomes activated only after the mobile has correctly received a call or transmitted its identification code. In the manual mode, the handset becomes activated when removed from its holder.

When the mobile is "on-hook", a negative signal is applied from the hook bistable (P) to the base of Q65 via R170. As a result, Q65 is turned on and the positive signal developed at its output drives Q66 into saturation. The collector of Q66 then goes negative causing Q67 to go into saturation and Q68 to go into cut off. With Q67 in saturation, the audio line from the handset microphone (10) is shorted to ground (11). With Q68 in cut off, the audio path from the output of the receiver (21) to the handset earpiece (5) is interrupted. Consequently, while the mobile is on-hook, the handset microphone and earpiece are muted.

Whenever the mobile is "off-hook" and the connect tone is being transmitted, the oscillator #1 control gate (R) feeds a positive signal to the base of Q66 via CR38. This holds Q66 in saturation and, as previously described, the handset remains in a muted condition.

After the mobile has correctly received a call or transmitted its identification code, the base of Q65 receives a positive signal from the selector inverter (G) via R171. This turns off Q65 which in turn drives Q66 into cut off. The collector of Q66 then goes positive causing Q67 to go into cut off and Q68 to go into saturation. The result is that the audio line from the handset microphone is removed from ground and the audio path from the output of the radio receiver to the handset earpiece is completed. This activates the handset to answer the incoming call or to receive dial tone prior to dialing the number of the party to be called. When the dial on the control head is cocked to dial a digit, a set of normally open dial contacts are closed. When this occurs, a positive signal is applied from the contacts (9) to the base of Q66 via CR37 and R177. This drives Q66 into saturation and, as previously described, the handset is disabled.

In the manual mode of operation, when the handset is removed from its holder, a negative signal is applied from the hookswitch contacts (9) to the base of Q66 via CR36. This drives Q66 into cut off and the handset becomes activated.

ac. Identifier Astable

The identifier astable (Q94 and Q95) is an astable multivibrator circuit. It is normally

the gate is turned on for 400 ms by the 350 ms timer ($\overline{L}$) and the 50 ms timer ($\overline{M}$). When the mobile initiates a call, the gate is turned on for 50 ms by the 50 ms timer ($\overline{M}$). When the mobile is identifying or sending disconnect tone, the gate is alternately turned on and off for 25 ms periods by signals from the identifier astable ($\overline{S}$). When the mobile is dialing, the gate is shunted for periods of 60 ms as the dial contacts alternately open and close.

x. Oscillator #2

Oscillator #2 is a tuned collector oscillator which consists of Q104, Q105 and Q106. The positive feedback to sustain oscillation is applied from the collector of Q105 to the base of Q105 via transformer T3 and emitter follower Q106. The emitter follower also isolates the oscillator from the mixer stage to prevent oscillator loading.

Frequency switching transistor (Q104) when turned on, switches the oscillator frequency from 1633 cps to 1336 cps. When the mobile is "on-hook", a positive signal is fed from the hook bistable ($\overline{P}$) to the base of Q104, driving it into saturation. Consequently, capacitor C99 is tied to E- through the low saturation resistance of Q104. This, in effect, parallels C99 across C100. The total capacitance across the transformer primary increases and the resonant frequency of the tank circuit decreases. The resulting oscillator frequency is then reduced to 1335 cps (disconnect tone) while "on-hook". When the mobile goes "off-hook", the positive signal applied to the base of Q104 is removed. As a result, Q104 is turned off and C99 is removed from the circuit. Consequently, the oscillator frequency is increased from 1336 cps, while "on-hook", to 1633 cps (connect tone) while "off-hook".

The oscillator is in operation at all times and supplies the stable tone necessary for the connect, or disconnect signal. The output from the oscillator is fed to a mixer stage via CR87 and R354. Normally negative signal is applied from the oscillator #2 control gate to Q107 via R349. This back biases the base-emitter junction inhibiting the output from the oscillator.

y. Mixer Gate

The mixer gate consists of Q102 and Q107 and associated circuitry. Normally, Q102 and Q107 are cut off.

When no tone signal is being transmitted, the bases of Q102 and Q107 are connected via R308 and R317 and R352 and R354, respectively, to the positive output from the transmitter keyer. The emitters of Q102 and Q107 are tied, respectively, to the output of the oscillator #1 control gate and the output of oscillator #2 control gate. Consequently, whenever the transmitter keyer is in the off condition, the mixer gate is turned off. When the transmitter keyer is turned on, a negative voltage is applied to the bases of Q102 and Q107. If the control gate is turned off, a negative voltage appears at the emitter of the mixer gate and it remains off. If the control gate output is positive, the mixer gate is turned on and a corresponding tone is transmitted. The output of the mixer gate is coupled to the transmitter Instantaneous Deviation Control circuit via transformer T3.

In the manual mode, Q102 is held cut off by the oscillator #1 control gate and Q107 is held cut off by a positive voltage (W) from the manual control.

z. Activity Checker

The activity checker circuit consists of integrators Q15 and Q16 and Schmitt trigger Q17 and Q18. In the automatic mode of operation, with no input applied to the circuit, Q18 is biased into saturation and Q15 is clamped in the off condition by a positive signal from the manual switch ⑥. This signal is applied to the base of Q15 via CR5. It prevents the input from the idle tone Schmitt trigger ($\overline{F}_i'$) from affecting the operation of the activity checker.

The main functions of the activity checker are to provide a signal to the hook inhibit circuit to prevent "off-hook" during signalling, to reset the pulse and digit counters prior to receipt of the coded calling signals from the base station and, prior to identification, prime the identifier bistable. In the automatic mode, the activity checker is turned on when seize tone is received by the mobile. In the manual mode, the receipt of either a 600 or 1500 cps tone activates the checker.

When seize tone is received by the mobile, a negative signal is coupled directly from the seize tone Schmitt trigger ($\overline{F}_s$) to the base of Q16 driving it into saturation A negative potential then appears at the emitter of Q16 causing C13 to charge negatively. When the charge on C13 is sufficient to forward bias the base-emit-

and identifier astable are again removed. The astable starts oscillating and the transmission of the disconnect signal commences. The parity bistable remains clamped in a preset condition by virtue of the negative signal from the 750 ms timer to the base of Q97 via CR106 and R299. After the timers period of operation (750 ms), it relaxes and the polarity of the signals to the identifier bistable and parity bistable are reversed. The circuits return to their original condition and the transmission of the disconnect signal ceases.

ae. Parity Bistable

The parity bistable (Q96 and Q97) is a bistable multivibrator circuit which is used to indicate pairs of connect tone pulses during mobile identification. It enables transmission of guard tone after every second pulse of connect tone and is normally clamped in a preset condition by a negative signal from the identifier bistable. When triggered by a positive pulse from the identifier astable, it changes state. Upon receipt of each even numbered pulse (2nd, 4th, etc) a positive signal is developed and coupled to one input of the oscillator #1 control gate. At the same time, a second gate input from the identifier astable also goes positive, the gate becomes fully activated and guard tone is transmitted. The output of the bistable goes negative with each odd numbered pulse (1st, 3rd, etc) and the gate remains off.

When the identifier bistable is triggered to initiate the transmission of the mobile identification code, the identifier astable starts oscillating and generating pulses. At the same time, the negative signal from the identifier bistable to the base of Q97 is removed and the parity bistable is unclamped in preparation to receive pulses from the astable. When the first pulse generated by the astable swings positive, it is applied to the base of Q96 via C88 and CR105 and to the base of Q97 via C90 and CR107. As a result, the parity bistable changes state and a negative signal is fed from the collector of Q97 to the oscillator #1 control gate via R302. Since the gate requires two positive inputs to become fully activated, the gate is held in the off condition. When the pulse from the astable swings negative, it is blocked by diodes CR105 and CR107 and the parity bistable remains in its existing condition.

A similar procedure occurs the second pulse from the astable swings positive. However, when the parity bistable changes stage, it is returned to its original condition and a positive pulse is fed from the collector of Q97 to one input of the oscillator #1 control gate. At the same time, a pulse is also applied from the identifier astable to a second gate input. While the pulse from the astable is positive, the gate becomes fully activated and guard tone is transmitted.

After the mobile transmits all seven digits of the mobile identification code, the identifier bistable is triggered and restored to its initial state. A negative signal (Q) is then reapplied to the base of Q97 via R301 and the parity bistable is held clamped in a preset condition.

af. Manual Control

The main function of the manual control (Q64) is to provide a negative signal in the automatic mode of operation and a positive signal in the manual mode of operation. In the automatic mode, Q64 is biased into cut off. The negative signal appearing at its collector (W) is fed to the tone detectors, digit counter, detector bistable, hook inhibit, and mixer gates.

When the manual mode of operation is selected at the control head, a negative signal is applied from the control head (6) to the base of Q64 via R165. This turns on the transistor and the positive signal derived from its output is applied to the same stages.

ag. Filter and Bias Supply

The voltage levels required for proper operation are developed in the filter and bias supply. These voltages are derived as follows;

A- and A+ are derived directly from the main power source.
B- is derived from A- through an LC filter network.
C- is derived from B- through an RC filter network.
D- is derived from B- through a silicon diode.
E- is derived from D- through a silicon diode.
B+ is derived from A+ through a voltage regulator Q108.
C+ is derived from A+ through a voltage regulator Q109.

7. SERVICE AIDS

a. Disassembly

(1) Remove the radio set housing as described in the SERVICE AIDS portion of the RADIO SET section of this manual.

clamped in a cut off condition by a positive signal from the identifier bistable ($\bar{Q}$). When the clamping voltage is removed, the astable oscillates and generates 25 ms pulses every 50 ms. These pulses are applied to various circuits in the unit for the transmission of the disconnect signal and mobile identification code.

When the identifier bistable is triggered to initiate the transmission of the mobile identification code, it changes state and the positive clamping voltage is removed from the base of Q94. The astable then starts oscillating and a 25 ms pulse is generated every 50 ms. These pulses are fed to the parity bistable, the oscillator #1 and oscillator #2 control gates, and to the pulse counter for the transmission of the mobile identification code.

After the pulse counter has counted a predetermined number of pulses for transmission of the first code digit, the interdigit timer becomes activated. When this occurs, a positive signal (K) is fed to the base of Q94 via CR103. This signal cuts off the astable for approximately 190 ms (interdigit timers period of operation). At the end of this time interval, the interdigit timer relaxes and the positive signal is removed from the base of Q94. The astable then starts oscillating and the cycle described in the preceding paragraphs is repeated for the transmission of the next code digit.

After the seventh digit of the code is transmitted, the identifier bistable is triggered and returned to its normal state. The clamping signal from the bistable to the base of Q94 is then reapplied and astable operation ceases.

When the mobile goes "on-hook" after completion of a call, the identifier bistable is triggered by the 750 ms timer. When this occurs, the clamping signal from the base of Q94 is removed and the astable begins to oscillate to initiate the transmission of the disconnect signal. After the 750 ms timer's period of operation, the identifier bistable is again triggered, the clamping signal to the base of Q94 is reapplied, the astable is prevented from operating, and transmission of the disconnect signal ceases.

ad. Identifier Bistable

The identifier bistable (Q92 and Q93) is a bistable multivibrator circuit which operates in conjunction with a two input "NOR" gate. It inhibits operation of the identifier astable and parity bistable whenever the mobile identification code and disconnect signal are not being transmitted. In addition, during mobile identification, it inhibits the output of the detector bistable. Initially, Q91 and Q92 are biased into saturation and Q93 is biased into cut-off. When this condition exists, a positive inhibit signal is applied from the collectors of Q91 and Q92 to the identifier astable and a negative inhibit signal is fed from the collector of Q93 to the parity bistable.

When the mobile successfully goes "off-hook", a positive signal is applied from the hook bistable (P) to the base of Q91 via R331 and CR113, turning it off. The identifier astable remains clamped in the off condition since it continues to receive a positive inhibit signal from the collector of Q92. If the action of going "off-hook" was initiated to originate a call, the base station then makes the channel busy by removing the idle tone and later replacing it with seize tone. This activates the seize tone Schmitt trigger and the activity checker. When the base station is prepared to receive the mobile identification code, seize tone is removed from the channel and the seize tone Schmitt trigger reverts to its original condition. The activity checker turns off 190 ms later and a positive pulse ($\bar{J}$) is coupled to the base of Q92 via C110 and CR114 and the identifier bistable changes state. The inhibit signals from the identifier bistable to the identifier astable and parity bistable are then removed, the output of the detector bistable is blocked by negative signal from the collector of Q92 and mobile identification commences.

After the seventh digit of the identification code is transmitted, Q91 is driven into saturation by a negative signal from the selector inverter ($\bar{G}$) to its base via R328. The resulting positive signal at the collector of Q91 is fed to the identifier astable via CR104 and to the base of Q93 via R334. This turns off the identifier astable and reverts the identifier bistable to its original state. As a result, the output of the detector bistable is no longer inhibited, the parity bistable is clamped in a preset condition and mobile identification ceases.

When the mobile goes "on-hook" after completion of the call, the hook bistable is restored to its initial state, the 750 ms timer becomes activated and a positive and negative signal are generated. The positive signal (T) is applied to the base of Q91, driving it into cut off. The negative signal ($\bar{T}$) is applied to the base of Q93 and to the parity bistable via CR106 and R299. Consequently, the identifier bistable changes state and the inhibit signals to the parity bistable

(2) Refer to Figure 10. Lift up the supervisory unit by releasing the spring latch with one finger while simultaneous pulling up with another.

(3) Refer to Figure 11. Release the spring latch and swing out the oscillator and detector circuit board.

(4) Refer to Figure 12. If access to the printed circuit side of the control and selector board is desired, remove the three screws at each end of the boards.

(5) If separation from the radio set is desired, remove the plug and the screw indicated in Figure 12.

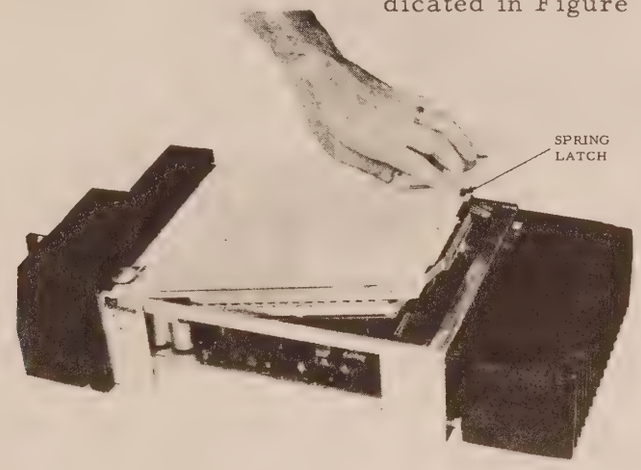


Figure 10
Opening of Supervisory Unit

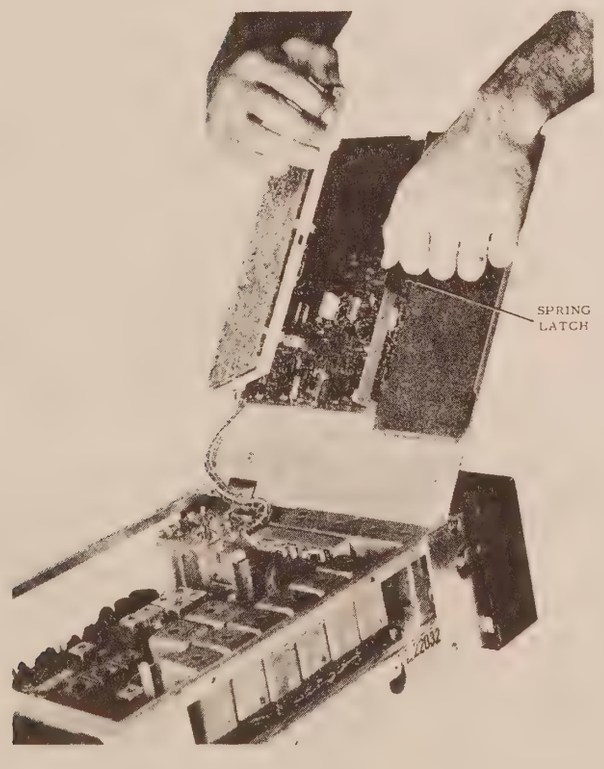


Figure 11
Unfolding of Supervisory Circuit Boards

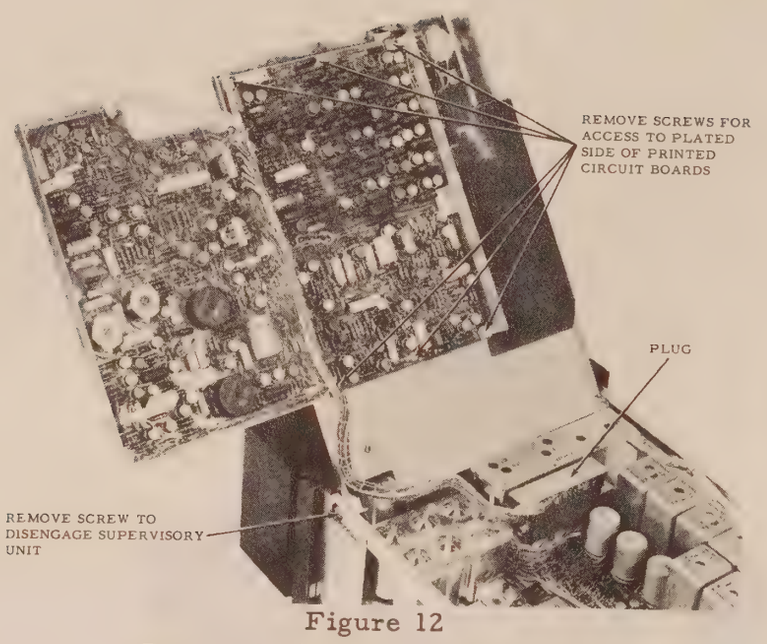


Figure 12
Removal of Printed Circuit Boards

b. Troubleshooting

Refer to the TROUBLESHOOTING CHART for aid in locating possible component failures.

Refer to the VOLTAGE MEASUREMENTS CHART for the approximate voltage readings that should be available at each element of the transistors.

Refer to the CIRCUIT ROUTING CHART for aid in signal tracing.

c. Phone Number Assignment

When a radio set is put into service in a radiotelephone system, a calling code (phone number) is assigned which establishes pulsed tone combinations to which the decoder will respond. Any code combination from 1111111 to 0000000 may be used.

NOTE

In determining the 7-digit code to be set up in a given supervisory unit, the first 3 digits will be the area code for the city in which the mobile is registered, NOT the office code (exchange) number under which the phone will be listed.

EXAMPLE: If the mobile telephone is registered in Chicago (Area Code 312) and the listed number of the phone is 772-6501, the number which would be set up in the supervisory unit is 312-6501.

The colored jumper leads (with pin connectors), located underneath the supervisory unit chassis plate on the selector printed circuit board, must be connected to the designated digit connector to set up the code. The numbers on the leads and on the board indicate the digits to which they correspond (see Chart A). There are connecting pins for the jumpers at points numbered 1 through 0 and at the base of each jumper. To set up the proper code, proceed as follows:

(1) For Code Numbers Containing Different Digits

Connect the proper color coded jumper leads to the desired digit connecting pin terminals. Refer to Chart A.

(2) For Code Numbers Containing Similar Digits

Connect the first digit jumper lead to the desired digit connecting terminal. If the second digit is the same as the first digit, connect the second digit jumper lead to the connecting terminal at the base of the first digit jumper lead. (Refer to figure 13.) If the third digit is the same as the first or second digit, connect the third digit jumper lead to the connecting terminal at the base of the first or second digit jumper lead depending upon which is connected to the same digit as the third digit of the code. Connect the fourth and fifth digit jumper leads in a similar manner.

If all the digits of the code are the same, connect the first digit jumper lead to the proper digit connecting pin. Then connect the second digit jumper lead to the connecting pin at the base of the first digit jumper lead and so on following the same pattern using the remaining digit jumper leads.

CHART A

CODE DIGITS	JUMPER LEAD COLOR
1st	Brown
2nd	Red
3rd	Orange
4th	Yellow
5th	Green
6th	Blue
7th	White

Refer to Figure 13. Using the number 870-3556 as an example, proceed as follows:

(a) Select the first digit jumper lead (numbers appear to the left of the jumper lead) and connect it to the desired phone number digit pin (numbers appear to the right of the pin) (in this example - pin 8).

(b) Select the second digit jumper lead from the left hand column and connect it to the desired phone number digit in the right hand column (7).

(c) Proceed in a similar manner with the third, fourth and fifth digits. Since the sixth digit is the same as the fifth digit, connect the sixth jumper lead to the fifth jumper terminal.

(d) Select the seventh digit jumper lead and connect it to the last phone number digit (6).

(3) 5-Digit Operation

When the unit is to be operated with a 5-digit phone number: proceed as follows:

(a) Remove the WHT-YEL wire from the 7-digit connection pin and connect it to the 5-digit pin. (Refer to EPD-10272 Selector Circuit Board Detail provided in the diagram booklet.)

(b) Set the first five digit jumper leads to the digits of the phone number as outlined above. (In the case of 5-digits, the area code is not substituted for the first 3 digits.) Connect the sixth digit jumper lead to the fifth jumper terminal, and the seventh digit jumper lead to the sixth jumper terminal.

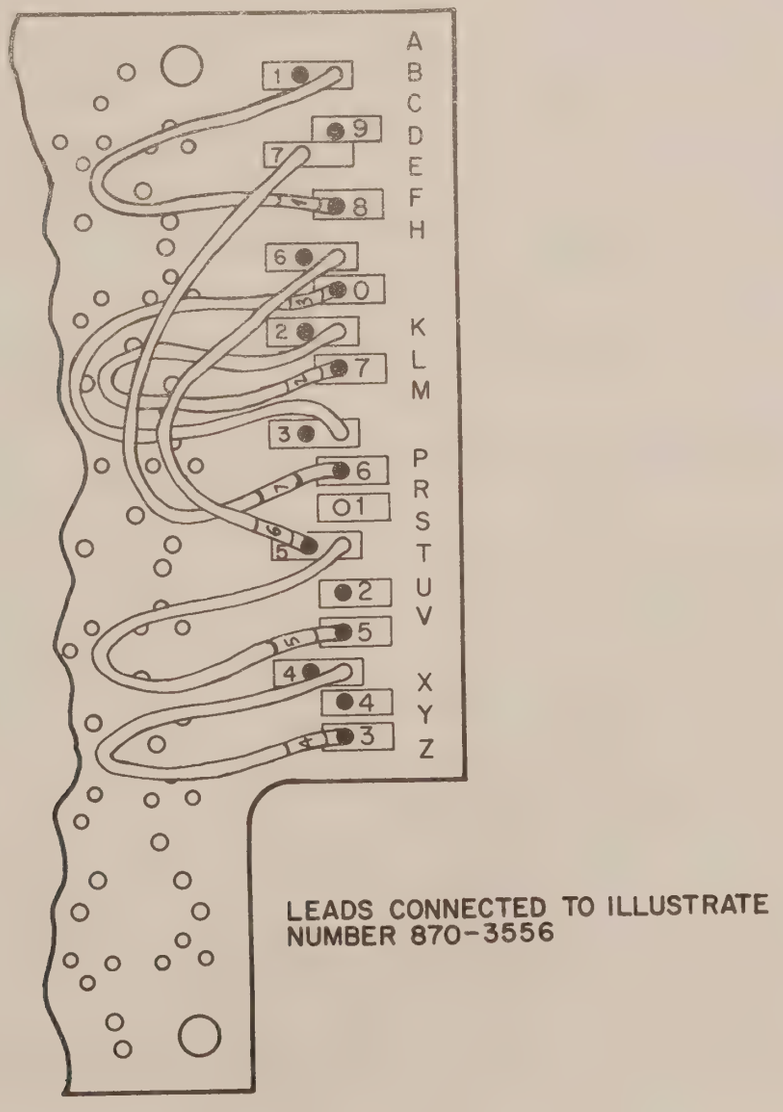


Figure 13
"Phone Number" Set-Up Detail

TROUBLE SHOOTING CHART

SYMPTOM	POSSIBLE CAUSE	
	Open	Shorted
SEARCHES CONTINUOUSLY - DOES NOT LOCK ON IDLE TONE		
In both automatic and manual mode of operation.		Q79
In automatic mode of operation only. Can be called in manual mode of operation	Q73, Q74 Q76, Q78 CR58	Q4, Q75 Q77, Q8 Q89
In automatic mode of operation only. Cannot be called in manual mode. Can come off-hook in manual mode	Q2, Q5, Q6, CR8	Q1, Q2, Q7, CR1, CR7
In automatic mode of operation only. Cannot be called in manual mode. Cannot come off-hook anytime.	CR1, CR7	Q10, Q11
3# DOES NOT SEARCH		
Can be called if on idle channel. Does not search if mismatch occurs.	Q79, Q77 Q75, CR62 CR69, CR67 CR68, CR64	Q78, Q76
Can be called if on idle channel. Drops off channel if mismatch occurs.	CR59	Q73
Cannot be called. Cannot make a call in automatic mode of operation. Can make a call in manual mode.	Q7, Q12	Q5, Q6
CANNOT BE CALLED IN MANUAL MODE OF OPERATION-HANDSET NOT MUTED		
Can make a call in manual. Cannot send tones in manual if dial is cocked and released.	Q3, Q4, Q8, Q9 CR2	
Can make a call in manual. Can send tones in manual if dial is cocked and released.	Q64 CR123	
CANNOT BE CALLED IN AUTOMATIC MODE OF OPERATION - HANDSET NOT MUTED		
Can be called in manual mode of operation.		Q3, Q9 Q64
CANNOT BE CALLED IN AUTOMATIC OR MANUAL MODE OF OPERATION - HANDSET NOT MUTED		
Can come off-hook during signalling. Will not identify.	Q1, Q10, Q11	Q12

SYMPTOM	POSSIBLE CAUSE	
	Open	Shorted
Will identify to initiate a call. Cannot come off-hook during signalling. Does not search while signalling is present	Q13, Q14 CR3, CR6 CR4, CR13 CR14	Q13, Q14 CR2
CANNOT BE CALLED IN AUTOMATIC OR MANUAL MODE OF OPERATION - HANDSET ALWAYS MUTED		
Sends continuous guard tone to identify or disconnect. Does not search with code mismatch.	Q19	Q20, Q21
Continuously sends first digit of address when identifying. Does not search with code mismatch.	Q22	Q22
Sends continuous pulses of connect and guard tone with parity when identifying. Does not search with code mismatch.	Q20, Q21 Q44, Q45 CR21, CR45	Q19
Sends continuous pulses of connect and guard tone with parity when identifying. Starts searching after first digit of address.	Q24, Q25 Q27, CR14	Q25
Sends continuous pulses of connect and guard tone with parity when identifying. Pulse counter steps to first element and remains there (can't be reset). Starts searching after first digit of address.		Q24, Q26 Q27
Does not respond to numbers greater than one.	Q29	
Does not respond to numbers greater than two.	Q31	Q28, Q29
Does not respond to numbers greater than three.	Q33	Q30, Q31
Does not respond to numbers greater than four.	Q35	Q32, Q33
Does not respond to numbers greater than five.	Q37	Q34, Q35
Does not respond to numbers greater than six.	Q39	Q36, Q37
Does not respond to numbers greater than seven.	Q41	Q38, Q39
Does not respond to numbers greater than eight.	Q43	Q40, Q41
Does not respond to numbers greater than nine.		Q42, Q43
Continually sends second digit to identify. Digit counter is always stepped to the first element.	CR39	Q44, Q46 Q47, CR12 CR39
Continually sends third digit to identify. Digit counter is always stepped to the second element.		Q48, Q49

SYMPTOM	POSSIBLE CAUSE	
	Open	Shorted
Continually sends fourth digit to identify. Digit counter is always stepped to the third element.		Q50, Q51
Continually sends fifth digit to identify. Digit counter is always stepped to the fourth element.		Q52, Q53
Continually sends sixth digit to identify. Digit counter is always stepped to the fifth element.		Q54, Q55
Continually sends seventh digit to identify. Digit counter is always stepped to the sixth element.		Q56, Q57
Responds to first code digit only. Searches after first code digit. Identifies continually with first digit only. Sends connect tone in space between first and second pulse of each digit.	Q46, Q47 CR20, CR23	Q45, CR42
Responds to first two code digits only. Searches after second code digit. Identifies continually with the first two digits of the address. Sends connect tone in the space between the first and second pulse of the first digit.	Q48, Q49 CR22, CR25	
Responds to first three code digits only. Searches after third code digit. Identifies continually with the first three digits of the address. Sends connect tone in the space between the first and second pulse of the first digit.	Q50, Q51 CR24, CR27	
Responds to first four code digits only. Searches after fourth code digit. Identifies continually with the first four digits of the address. Sends connect tone in the space between the first and second pulse of the first digit.	Q52, Q53 CR26, CR29	
Responds to first five code digits only. Searches after fifth code digit. Identifies continually with the first five digits of the address. Sends connect tone in the space between the first and second pulses of the first digit.	Q54, Q55 CR28, CR31	
Responds to first six code digits only. Searches after sixth code digit. Identifies continually with the first six digits of the address. Sends connect tone in the space between the first and second pulses of the first digit.	Q56, Q57 CR30, CR33	
Responds to proper code but does not acknowledge. Identifies continually with all seven digits of the address. Sends connect tone in the space between the first and second pulses of the first digit.	Q58, Q59 CR32	Q60

SYMPTOM	POSSIBLE CAUSE	
	Open	Shorted
Does not acknowledge when called.	Q61	
Does not ring when ringing pulses are sent.	Q62, Q63	CR35
Bell does not stop when mobile comes off-hook.	CR34	
Does not ring in manual mode.	CR124	
FALSES ON WRONG NUMBER		
In manual or automatic mode of operation. Searches when own number is called.	Q26, Q28 Q30, Q32 Q34, Q36 Q38, Q40 Q42	
In automatic mode of operation, falses when signalling begins. Will not identify or disconnect. Can come off-hook any time. In manual mode of operation, bell rings continuously.	Q60	Q58, Q59
In automatic mode of operation, falses when signalling begins. Bell rings periodically while identifying. Can come off-hook any time. In manual mode of operation, bell rings continuously		Q61
Rings continuously when turned on.		Q62, Q63
In manual mode of operation, bell can't be reset by operator.	CR12	
Falses with any number for the first digit of the address.		CR20
Falses with any number for the second digit of the address.		CR22
Falses with any number for the third digit of the address.		CR24
Falses with any number for the fourth digit of the address.		CR26
Falses with any number for the fifth digit of the address.		CR28
Falses with any number for the sixth digit of the address.		CR30
Falses with any number for the seventh digit of the address.		CR32

SYMPTOM	POSSIBLE CAUSE	
	Open	Shorted
HANDSET		
Always muted.	Q66	
Always muted. Dialing is inhibited.		Q65
Microphone always muted.		Q67
Earpiece always muted.	Q68, CR47	
Live at all times except when sending connect or disconnect tones. Dialing is not inhibited when identifying.	Q65	
Always live.		Q66
Microphone always live.	Q67	
Earpiece always live.	CR40	Q68
DOES NOT TRANSMIT		
In automatic or manual mode of operation.	Q70, Q71 CR82, CR41	
In automatic mode of operation when off-hook. 350 ms timer does not turn on.	Q82, Q83 Q85, CR88	Q82, Q83 Q84, CR126
While on-hook. Does not acknowledge. Does not disconnect.	Q81, CR76 CR77, CR78	Q80
TRANSMITS CONTINUOUSLY IN AUTOMATIC OR IN MANUAL MODE OF OPERATION.		
Does not search.		Q70, CR41
Searches in automatic when tones are lost.	Q71	
Does not disconnect when going on-hook.	Q84	Q85, CR66
DOES NOT TRANSMIT PROPER TONES		
Transmits 50 ms of connect tone when answering or initiating a call.	Q87, CR101 CR116	Q87
Transmits continuous connect tone when answering a call; none when initiating a call.	Q88	

SYMPTOM	POSSIBLE CAUSE	
	Open	Shorted
Transmits continuous pulses of disconnect and guard tone when on-hook and connect and guard tone when off-hook.	Q80	
Transmits continuous guard tone after identification or after answering a call.		Q81
Transmits continuous connect tone when off-hook, during acknowledge or disconnect	Q90 Q95	
No connect tone when coming off-hook.	CR70	Q88
No connect tone when initiating a call. 350 ms of connect tone when answering a call. Does not search if a code mismatch occurs.	Q89, CR102	Q90
Transmits guard tone after each burst of connect tone during identification. No parity.	Q96, CR107	Q97
Transmits only connect tone during identification. No parity.	Q97, CR106	Q96
Transmits continuous pulses of connect tone with parity during identification.	CR103	
Transmits continuous guard tone.	Q98	Q99
Does not transmit guard tone.	Q99,100, 101 Q102, CR83	Q98,100, Q101, 102, CR83
Does not send connect or disconnect tone except while dialing.	Q103, Q105, CR87, CR118	Q105, Q106, CR87
Transmits continuous disconnect tone while on-hook and connect tone while off-hook.	CR120	Q103
Transmits connect tone instead of disconnect tone.	Q104, CR121, CR122	
Transmits disconnect tone instead of connect tone.		Q104
Transmits 400 ms of connect tone when initiating a call.	CR115	
Transmits parity tones during disconnect	CR106	
Does not transmit identity pulses. Does not disconnect.	Q93, Q93 CR117, CR128	Q91, Q92, Q94, Q95

SYMPTOM	POSSIBLE CAUSE	
	Open	Shorted
Identifies repeatedly. Can be stopped only with AUTO/MANUAL switch	Q91	
Identifies when unit comes off-hook to initiate a call.	Q92	Q93
Does not search with code mismatch.	Q23, CR57 CR74	Q23
Does not search with code mismatch. Locks on either idle or seize tone and on signalling.	CR62, CR60 CR61	Q74, CR63
Locks on either idle or seize tone and on signalling.	CR56	
Can be called. Sends alternate pulses of connect and guard tone to identify.	CR15, CR16	
Pulse counter is not reset between digits.	CR17	
Pulse counter is not reset before identification or code signalling.	CR18	
Digit counter is not reset before identification or code signalling.	CR19	
Digit counter does not reset when unit goes on-hook.	CR43	
Digit counter does not reset when unit starts to search.	CR45	
MISCELLANEOUS		
Transmits carrier for 750 ms after being signalled in manual.	CR52	
Searches when mobile comes off-hook.	CR50	
Cannot dial.	CR119	Q69, CR48
Can dial during identification.	Q69, CR48	
Busy lamp does not light.	Q72, CR51 CR55	
Busy lamp lights when transmitter is on	CR49	Q72, CR51

SYMPTOM	POSSIBLE CAUSE	
	Open	Shorted
Cannot come off-hook except when called. Cannot identify.	Q18, CR5	Q15, 16, 17
Comes off-hook anytime unit is locked on channel. Cannot identify.	Q15, Q16 Q17 CR65	Q18, CR88

VOLTAGE MEASUREMENTS CHART

NOTES:

1. Static voltage conditions are obtained with no signals applied to the supervisory unit.
2. To determine the operative conditions of the stages, refer to the instruction manual.
3. All voltages are measured with a Motorola DC Multimeter unless otherwise indicated.
4. A single asterisk (*) indicates voltages measured with a Motorola Model T1015A General Purpose Oscilloscope.
5. A double asterisk (**) indicates the maximum positive value of an exponentially decaying voltage.
6. A- is 13.6 volts d-c. A+ is 0 volts d-c.

All readings given in volts.

		STATIC	OPERATIVE
Q1	e	2.0	3.0
	b	3.2	3.2
	c	10.0	10.0
Q2	e	3.2	3.2
	b	3.0	3.0
	c	10.0	10.0
Q3	e	10.0	9.5
	b	13.4	9.0
	c	10.0	9.5
Q4	e	12.0	12.0
	b	13.5	11.4
	c	0	12.1
Q5	e	12.5	12.3
	b	12.6	12.6
	c	.3	11.8
Q6	e	1.4	1.4
	b	.1	1.6
	c	11.2	1.5
Q7	e	1.4	1.4
	b	1.6	.5
	c	1.5	8.0
Q8	e	10.0	9.2
	b	9.6	9.8
	c	10.0	9.2
Q9	e	12.0	12.0
	b	13.4	11.4
	c	0	12.1
Q10	e	12.5	12.3
	b	12.6	12.6
	c	.3	11.6
Q11	e	1.4	1.2
	b	.1	1.4
	c	11.2	1.3

		STATIC	OPERATIVE
Q12	e	1.4	1.2
	b	1.6	.5
	c	1.5	10.5
Q13	e	1.8	1.8
	b	.7	2.0
	c	10.5	1.9
Q14	e	1.8	1.8
	b	2.0	.7
	c	1.9	10.0
Q15	e	1.2	8.0
	b	-.3	8.2
	c	13.6	13.0
Q16	e	1.2	10.0
	b	1.4	10.2
	c	13.6	13.0
Q17	e	2.3	1.1
	b	.5	1.3
	c	10.5	1.2
Q18	e	2.3	1.1
	b	2.5	.4
	c	2.4	12.5
Q19	e	0	0
	b	.22	0*
	c	.1	12.4*
Q20	e	.1	12.2
	b	.1	12.4*
	c	13.4	12.3*
Q21	e	1.1	1.3
	b	.05	1.5
	c	9.0	1.4
Q22	e	1.2	1.3
	b	1.4	.5
	c	1.3	10.5

		STATIC	OPERATIVE
Q23	e	0	0
	b	.2	0*
	c	.1	10.5*
Q24	e	0	0
	b	.2	0*
	c	.1	12.8*
Q25	e	.6	.76
	b	.8	.42
	c	.7	12.0
Q26	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q27	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q28	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q29	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q30	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q31	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q32	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q33	e	.6	.76
	b	0	1.05
	c	12.0	.8

		STATIC	OPERATIVE
Q34	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q35	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q36	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q37	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q38	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q39	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q40	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q41	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q42	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q43	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q44	e	0	0
	b	.2	0*
	c	.1	12.8*
Q45	e	.6	.76
	b	.8	.42
	c	.7	12.0
Q46	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q47	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q48	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q49	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q50	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q51	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q52	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q53	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q54	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q55	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q56	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q57	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q58	e	9.6	1.05
	b	12.0	.8
	c	0	1.05
Q59	e	.6	.76
	b	0	1.05
	c	12.0	.8
Q60	e	1.8	1.8
	b	2.0	.3
	c	1.9	8.8
Q61	e	1.8	1.8
	b	.7	2.0
	c	10.0	1.9
Q62	e	10.0	1.9
	b	.45	2.1
	c	13.6	2.0
Q63	e	4.6	2.2
	b	13.6	2.0
	c	0	2.1
Q64	e	1.8	1.8
	b	.45	2.1
	c	13.6	1.9
Q65	e	1.8	1.8
	b	2.0	.9
	c	1.9	12.0
Q66	e	12.9	12.9
	b	12.3	11.8
	c	13.0	2.2
Q67	e	3.8	2.4
	b	4.0	2.3
	c	3.9	3.2
Q68	e	8.0	6.8
	b	12.6	6.0
	c	3.6	6.5
Q69	e	13.6	12.2
	b	13.4	12.0
	c	13.6	12.1
Q70	e	1.8	1.8
	b	.5	2.0
	c	13.6	1.9
Q71	e	13.0	11.0
	b	13.6	10.4
	c	+.7	10.6
Q72	e	0	13.0
	b	0	12.4
	c	+.6	12.6
Q73	e	1.8	1.8
	b	.60	2.0
	c	11.5	1.9
Q74	e	1.8	1.8
	b	2.0	.9
	c	1.8	3.2
Q75	e	1.6	1.2
	b	1.8	.7
	c	1.7	11.6
Q76	e	2.2	1.4
	b	.60	1.6
	c	10.4	1.5
Q77	e	2.2	1.4
	b	2.4	.35
	c	2.3	11.8
Q78	e	1.8	1.8
	b	.55	2.0
	c	10.8	1.9
Q79	e	.7	.7
	b	.9	.2
	c	.8	10.7
Q80	e	0	0
	b	.2	+10.0**
	c	.1	9.5*
Q81	e	.7	.7
	b	0	.9*
	c	10.5	.8*

		STATIC	OPERATIVE
Q82	e	1.6	1.3
	b	1.8	.4
	c	1.7	11.5
Q83	e	1.6	1.3
	b	0	1.5
	c	8.0	1.4
Q84	e	1.8	1.8
	b	2.0	.8
	c	1.9	10.5
Q85	e	1.8	1.8
	b	.7	2.0
	c	10.0	1.9
Q87	e	1.8	1.8
	b	0	1.9*
	c	13.0	2.0*
Q88	e	0	0
	b	.2	+11.0**
	c	.1	9.0*
Q89	e	1.8	1.8
	b	0	1.9*
	c	13.0	1.8*
Q90	e	0	0
	b	.2	+10.5**
	c	.1	10.0*

		STATIC	OPERATIVE
Q91	e	1.8	1.8
	b	2.0	.8
	c	1.9	9.5
Q92	e	1.8	1.8
	b	2.0	.4
	c	1.9	9.5
Q93	e	1.8	1.8
	b	.65	2.0
	c	11.0	1.9
Q94	e	3.8	3.4
	b	2.5	3.6*
	c	13.6	3.5*
Q95	e	0	0
	b	.2	+12.0**
	c	.1	13.6*
Q96	e	1.8	1.8
	b	.6	2.0*
	c	11.6	1.9*
Q97	e	1.8	1.8
	b	2.0	.6*
	c	1.9	11.6*
Q98	e	1.8	1.8
	b	2.0	.4
	c	1.9	11.6
Q99	e	1.8	1.8
	b	.7	2.0
	c	13.6	1.9

		STATIC	OPERATIVE
Q100	e	-	7.6
	b	-	6.6
	c	-	13.0
Q101	e	-	6.6
	b	-	6.8
	c	-	13.6
Q102	e	3.0	6.2
	b	+.6	6.4
	c	13.6	13.6
Q103	e	1.8	1.8
	b	0	2.0*
	c	13.5	1.9*
Q104	e	12.6	12.6
	b	12.0	13.2
	c	12.2	0
Q105	e	-	7.6
	b	-	6.6
	c	-	13.0
Q106	e	-	6.6
	b	-	6.8
	c	-	13.6
Q107	e	13.5	6.2
	b	+.6	6.4
	c	13.6	13.6
Q108	e	1.8	1.8
	b	1.5	1.5
	c	.6	.6
Q109	e	1.8	1.8
	b	1.5	1.5
	c	.6	.6

CIRCUIT ROUTING CHART

NOTES:

1. This chart for use with Schematic Diagram 63E81021A27.
2. Input and output lead symbols indicated by an arrow → refer to direct connections between stages.

INPUT FROM	LEAD SYM	CIRCUIT	LEAD SYM	OUTPUT TO
REC AND HI (DC) REC AUD LO	⑰ ④	AMP & CLIPPER, Q1, Q2	→	IDLE TONE DETECTOR
			→	SEIZE TONE DETECTOR
AMP & CLIPPER MANUAL CONTROL	→ W	IDLE TONE DETECTOR Q3, Q4, Q5	→	IDLE TONE SCHMITT
IDLE TONE DETECTOR	→	IDLE TONE SCHMITT Q6, Q7	F_i	HOOK INHIBIT
			F_i	HOOK RESET
			$\overline{F}_i'$	HOOK RESET
			$\overline{F}_i'$	CHANNEL LATCH CONTROL
			$\overline{F}_i'$	ACTIVITY CHECKER
			$\overline{F}_i'$	DETECTOR BISTABLE
AMP & CLIPPER MANUAL CONTROL	→ W	SEIZE TONE DETECTOR Q8, Q9, Q10	→	SEIZE TONE SCHMITT
SEIZE TONE DETECTOR	→	SEIZE TONE SCHMITT Q11, Q12	F_s	CHANNEL LATCH CONTROL
			$\overline{F}_s$	CHANNEL LATCH CONTROL
			$\overline{F}_s$	ACTIVITY CHECKER
			$\overline{F}_s$	DETECTOR BISTABLE
IDLE TONE SCHMITT	$\overline{F}_i'$	DETECTOR BISTABLE Q13, Q14	→	INTERDIGIT TIMER
SEIZE TONE SCHMITT	$\overline{F}_s$			
MANUAL CONTROL IDENTIFIER BISTABLE CHANNEL LATCH CONTROL	W $\overline{Q}$ →		→	SELECTOR INPUT GATE
IDLE TONE SCHMITT	$\overline{F}_i'$	ACTIVITY CHECKER Q15, Q16, Q17, Q18	J	SELECTOR INPUT GATE
SEIZE TONE SCHMITT	$\overline{F}_s$		$\overline{J}$	IDENTIFIER BISTABLE
MAN SW	⑥		$\overline{J}$	HOOK INHIBIT
DETECTOR BISTABLE 750 MS TIMER DIGIT COUNTER	→ $\overline{T}$ →	INTERDIGIT TIMER Q19, Q20, Q21, Q22	K $\overline{K}$ $\overline{K}$ $\overline{K}$	IDENTIFIER ASTABLE MISMATCH GATE SELECTOR INPUT GATE RINGER CONTROL
INTERDIGIT TIMER DIGIT COUNTER RESET	$\overline{K}$ H	MISMATCH GATE Q23	V	50 MS TIMER

INPUT FROM	LEAD SYM	CIRCUIT	LEAD SYM	OUTPUT TO
DETECTOR BISTABLE	→	SELECTOR INPUT GATE	→	PULSE COUNTER DRIVER
IDENTIFIER ASTABLE	$\overline{S}$	CR11 - CR19, CR39,		
IDENTIFIER BISTABLE	$\overline{Q}$	CR42-CR44	→	PULSE COUNTER RESET
INTERDIGIT TIMER	$\overline{K}$			
ACTIVITY CHECKER	J		→	DIGIT COUNTER DRIVER
DIGIT COUNTER	$\overline{G}$			
MANUAL CONTROL	W		→	DIGIT COUNTER RESET
HOOK BISTABLE	$\overline{P}$			
SEARCH	⑧			
SELECTOR INPUT GATE	→	PULSE COUNTER DRIVER Q24	→	PULSE COUNTER RESET
			→	PULSE COUNTER RESET
SELECTOR INPUT GATE	→	PULSE COUNTER RESET ("O" ELEMENT) Q25	→	DIGIT COUNTER ELEMENT
PULSE COUNTER DRIVER	→			
PULSE COUNTER DRIVER	→	PULSE COUNTER ELEMENTS Q26, Q27, Q28, Q29, Q30, Q31, Q32, Q33, Q34, Q35, Q36, Q37, Q38, Q39, Q40, Q41, Q42, Q43	→	DIGIT COUNTER ELEMENTS
SELECTOR INPUT GATE	→	DIGIT COUNTER DRIVER Q44	→	DIGIT COUNTER RESET
			→	DIGIT COUNTER ELEMENTS
SELECTOR INPUT GATE	→	DIGIT COUNTER RESET Q45	H	MISMATCH GATE
DIGIT COUNTER DRIVER	→		→	INTERDIGIT TIMER
DIGIT COUNTER DRIVER	→	DIGIT COUNTER ELEMENTS Q46, Q47, Q48, Q49, Q50, Q51, Q52, Q53, Q54, Q55, Q56, Q57, Q58, Q59	→	SELECTOR INVERTER
PULSE COUNTER ELEMENTS	→		→	INTERDIGIT TIMER
750 MS TIMER	$\overline{T}$			
			$\overline{G}$	OSC #1 CONTROL GATE
			$\overline{G}$	OSC #2 CONTROL GATE
			$\overline{G}$	IDENTIFIER BISTABLE
			G	SELECTOR INPUT GATE (2)
DIGIT COUNTER ELEMENT	→	SELECTOR INVERTER Q60, Q61	$\overline{G}$	HOOK RESET
			G	750 MS TIMER
			G	RINGER CONTROL
			G	HANDSET CONTROL
			G	HOOK INHIBIT
SELECTOR INVERTER	G	RINGER CONTROL Q62, Q63	⑤	REC AND HSET/RINGER
HOOK BISTABLE	P			
INTERDIGIT SCHMITT	$\overline{K}$			
MAN	⑥			
MAN	⑥	MANUAL CONTROL Q64	W	MIXER GATE
			W	DETECTOR BISTABLE
			W	750 MS TIMER
			W	HOOK INHIBIT
			W	IDLE TONE DETECTOR
			W	SEIZE TONE DETECTOR
			W	SELECTOR INPUT GATE

INPUT FROM	LEAD SYM	CIRCUIT	LEAD SYM	OUTPUT TO
HOOK BISTABLE	P	HANDSET CONTROL	→	DIAL INHIBIT
SELECTOR INVERTER	G	Q65, Q66, Q67, Q68	⑩	MIC
DON/MAN HKS	⑨		⑪	SIGNAL LO
			㉑	REC AUD HI (DC)
DON/MAN HKS	⑨			
OSC #2 CONTROL GATE	R		⑤	REC AUD HSET/RINGER
			④	REC AUD LO
HANDSET CONTROL	→	DIAL INHIBIT Q69	②	DIAL PULSE
HOOK BISTABLE	$\overline{P}$	XMTR KEYER	U	CHANNEL LATCH CON-
750 MS TIMER	$\overline{T}$	Q70, Q71		TROL
			㉓	TRANS KEY
			→	BUSY LAMP DRIVER
TRANSMITTER KEYER	→	BUSY LAMP DRIVER	⑮	BUSY
HKS/PTT	⑦	Q72		
IDLE TONE SCHMITT	$\overline{F_i}'$	CHANNEL LATCH CON-	⑧	SELECTOR INPUT GATE
SEIZE TONE SCHMITT	F_s	TROL Q73, Q74, Q75,	⑧	SEARCH
SEIZE TONE SCHMITT	$\overline{F}_s$	Q76, Q78, Q79		RADIO
50 MS TIMER	M		N	HOOK INHIBIT
MAN	⑥		→	DETECTOR BISTABLE
TRANSMITTER KEYER	U			
HKS/PTT	⑦	750 MS TIMER	T'	OSC #1 CONTROL GATE
HOOK BISTABLE	$\overline{P}$		T'	IDENTIFIER BISTABLE
SELECTOR INVERTER	G	Q80, Q81	$\overline{T}$	PARITY BISTABLE
MANUAL CONTROL	W		$\overline{T}$	IDENTIFIER BISTABLE
350 MS TIMER	$\overline{L}$		$\overline{T}$	DIGIT COUNTER
			$\overline{T}$	INTERDIGIT TIMER
			$\overline{T}$	TRANSMITTER KEYER
			$\overline{T}$	HOOK INHIBIT
HKS/PTT	⑦	HKS SCHMITT	→	HOOK INHIBIT
		Q82, Q83		
HKS SCHMITT	→	HOOK INHIBIT	→	HOOK BISTABLE
750 MS TIMER	$\overline{T}$	CR84-CR86, CR88,		
CHANNEL LATCH CONTROL	N	CR89, CR92,		
ACTIVITY CHECKER	$\overline{J}$	CR125-CR127		
SELECTOR INVERTER	G			
MANUAL CONTROL	W			
DON/MAN HKS	⑨			
IDLE TONE SCHMITT	F_i			
HOOK INHIBIT	→	HOOK BISTABLE	$\overline{P}$	XMTR KEYER
HOOK RESET	→	Q84, Q85	$\overline{P}$	750 MS TIMER
			$\overline{P}$	OSC #2 SWITCH
			$\overline{P}$	SELECTOR INPUT GATE
			P	350 MS TIMER
			P	RINGER CONTROL
			P	IDENTIFIER BISTABLE
			P	HANDSET CONTROL

INPUT FROM	LEAD SYM	CIRCUIT	LEAD SYM	OUTPUT TO
IDLE TONE SCHMITT	F_i			
IDLE TONE SCHMITT	$\overline{F_i}$	HOOK RESET	→	HOOK BISTABLE
SELECTOR INVERTER	G			
50 MS TIMER	M			
350 MS TIMER	L			
MAN	⑥			
			$\overline{L}$	HOOK RESET
			$\overline{L}$	750 MS TIMER
HOOK BISTABLE	P	350 MS TIMER	$\overline{L}$	50 MS TIMER
MAN	⑥	Q87, Q88	$\overline{L}$	IDENTIFIER BISTABLE
			$\overline{L}$	OSC #2 CONTROL GATE
350 MS TIMER	$\overline{L}$	50 MS TIMER Q89,	$\overline{M}$	OSC #2 CONTROL GATE
MISMATCH GATE	V	Q89, Q90	$\overline{M}$	HOOK RESET
MAN	⑥		M	CHANNEL LATCH CONTROL
			M	OSC #1 CONTROL GATE
HOOK BISTABLE	P	IDENTIFIER BISTABLE	$\overline{Q}$	IDENTIFIER ASTABLE
ACTIVITY CHECKER	J	Q91, Q92, Q93,	$\overline{Q}$	SELECTOR INPUT GATE
750 MS TIMER	T'		$\overline{Q}$	DETECTOR BISTABLE
750 MS TIMER	T		Q	PARITY BISTABLE
SELECTOR INVERTER	G			
MAN	⑥			
350 MS TIMER	L			
IDENTIFIER BISTABLE	$\overline{Q}$	IDENTIFIER ASTABLE	$\overline{S}$	PARITY BISTABLE
INTERDIGIT TIMER	K	Q94, Q95	$\overline{S}$	OSC #1 CONTROL GATE
			$\overline{S}$	OSC #2 CONTROL GATE
			$\overline{S}$	SELECTOR INPUT GATE
IDENTIFIER BISTABLE	Q	PARITY BISTABLE	→	OSC #1 CONTROL GATE
IDENTIFIER ASTABLE	S	Q96, Q97		
750 MS TIMER	T			
750 MS TIMER	T'	OSC #1 CONTROL	→	MIXER GATE
IDENTIFIER ASTABLE	S	GATE Q89, Q90		
PARITY BISTABLE	→			
DON/MAN HKS	⑨			
DIAL PULSE	②			
SELECTOR INVERTER	G			
50 MS TIMER	M			
MAN	⑥			
		OSC #1 Q100, Q101	→	MIXER GATE
50 MS TIMER	M	OSC #2 CONTROL	R	HANDSET CONTROL
IDENTIFIER ASTABLE	S	GATE Q103	R	MIXER GATE
DIAL PULSE	②			
350 MS TIMER	I			
SELECTOR INVERTER	G			
HOOK BISTABLE	$\overline{P}$	OSC #2 SWITCH Q104	→	OSC #2
OSC #2 SWITCH	→	OSC #2 Q105, Q106	→	MIXER GATE

INPUT FROM	LEAD SYM	CIRCUIT	LEAD SYM	OUTPUT TO
OSC #1	→	MIXER GATE Q103, Q107	(19)	SIGNAL HI
OSC #2	→		(11)	SIGNAL LO
OSC #1 CONTROL GATE	→			
OSC #2 CONTROL GATE	R			
TRANS KEYER	(23)			
MANUAL CONTROL	W			
		FILTER & BIAS SUPPLY Q108, Q109	B+	OSC. & DET. BOARD
			C+	CONTROL BOARD

CONTROL HEAD



MODEL			COLOR
For BELL SYSTEMS Only	For "Independent" Systems	For Revertive Call Applications	
TCN6060A	TCN6070A	TCN6090A	Black
TCN6061A	TCN6071A	TCN6091A	White
TCN6062A	TCN6072A	TCN6092A	Red
TCN6063A	TCN6073A	TCN6093A	Blue
TCN6064A	TCN6074A	TCN6094A	Beige
TCN6065A	TCN6075A	TCN6095A	Turquoise
TCN6066A	TCN6076A	TCN6096A	Pink

1. DESCRIPTION

The control heads listed in the Model Chart are used with Motorola car telephone radio sets in IMTS mobile installations and are an integral part of the system. The TCN6060A Series Control Heads use a handset and dial assembly manufactured by WESTERN ELECTRIC CO., INC. and are for BELL SYSTEMS only. The control head consists basically of a control head assembly, a removable front panel, and a rear housing. Two metal arms with pressed in serrated threaded bushings extend from the rear housing for mounting the control head to a bracket.

The control head assembly includes a select mechanism, key-lock-switch, telephone dial, handset and holder, indicator lamps, ring relay, bell ringer, volume control, and associated components. The select mechanism incorporates 15 pushbutton switches which extend through the nameplate escutcheon. The AUX button at the right of the bottom row is for auxiliary call indication. The eleven buttons in the top row are for channel selection and the H, R, and M buttons at the left of the bottom row are for selecting the mode of operation (home-roam-manual). The home mode provides automatic duplex operation in multi-channel home IMTS areas. The roam mode provides automatic duplex operation when the equipment is used in multi-channel foreign areas where IMTS base station equipment exists. In the home or roam mode the channel for the next radiotelephone call is automatically selected. The manual mode provides non-automatic operation in MTS areas. In the manual mode the desired channel is selected by pushing the appropriate button on the control head. Etched lettering on the channel buttons indicates the specific channel associated with each button.

The TCN6090A Series Control Units are identical in external appearance to the models described above except that the AUX button is replaced by a P (Party) button. These models are used for revertive call applications to permit mobile to mobile contacts on a single channel by switching to push-to-talk control. If the auxiliary ring circuit is required, an external switch must be provided.

2. INSTALLATION AND OPERATION

Complete installation instructions are packed with the radio set. Refer to the INSTALLATION AND OPERATION instructions contained in the DESCRIPTION section of this manual for complete operating instructions.

3. THEORY OF OPERATION

Refer to Schematic Diagram 63D81021A77.

Primary power is furnished by the vehicle battery and is controlled by the key-lock-switch on the control head. When the switch is placed in the ON position, it becomes illuminated to provide a power on indication and battery power is applied to the radio set.

When an incoming call is received (key-lock-switch in the ON position and the handset in its holder), the ring relay operates and supplies A- to the bell ringer. The bell ringer is thus activated and the auxiliary alarm (if used) also is activated if the AUX button has been depressed. (The auxiliary alarm is connected

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as explained in the INSTALLATION AND OPERATION instructions packed with the radio set.) In the home or roam mode of operation, the bell ringer is turned on for two seconds and turned off for four seconds by command signals from the base station. This sequence continues for 45 seconds unless the handset is removed from its holder. In the manual mode of operation, ringing is continuous for 45 seconds unless the handset is removed from its holder.

When the handset is removed from its holder, the following functions are performed. A- is removed from the ring relay by the hookswitch. A signal path is completed from the REC AUD HSET/RINGER terminal to the handset earpiece via the hookswitch contacts and center arm of the volume control. A- is connected to the dial lamp through a hookswitch closure and the dial becomes illuminated. In the home or roam mode this same switch applies A- to the HKS/P-T-T terminal via the normally closed contacts of the manual pushbutton switch. In the manual mode A- is fed to the DON/MAN HKS and the HKS/P-T-T terminals through contacts on the manual pushbutton switch and the depressed push-to-talk switch. When the transmitter goes "on-the-air", the TRANS lamp illuminates. A- is applied to the transmit lamp from the TRANS KEY terminal via a diode.

When operating in the home or roam mode and the handset is removed from its holder to initiate a call and the channel is busy, the BUSY lamp is turned on and the call attempt is blocked. A- is applied the the BUSY LAMP terminal from the supervisory unit in the radio set. If, when in the manual mode, the handset is removed from its holder with the P-T-T button depressed, the BUSY lamp will be turned on and the call attempt is blocked until the button is released and pressed again while off hook. This prevents inadvertent transmission on an occupied channel before monitoring the channel.

The control head dial is used for dialing the number of the party to be called (home or roam mode). Dialing is the same as in standard telephone practice. When the dial is rotated from its normal position, the OFF-NORMAL contacts close. A+ is fed through the normally closed contacts of the manual pushbutton switch and the dial OFF-NORMAL contacts to the DON/MAN HKS terminal. When the dial is released, the dial pulsing contacts alternately open and close the same number of times as the digit dialed. For example, if the digit 5 is dialed, the dial pulsing contacts alternately open and close five times. When the contacts open, A- is removed from the dial pulsing terminal.

The control head select mechanism is composed of pushbutton switches. Three of the switches are used for selecting the mode of operation (H-home, R-roam, M-manual) and the remaining eleven are used for channel selection. With the H-button depressed, none of the channel buttons will be latched. With the R button depressed any set of eleven channel buttons may be depressed and latched. With the M button depressed, the eleven channel buttons may be depressed and latched one at a time.

The CHAN COMM terminal is connected via normally closed contacts on the home switch to a series and parallel bus on the channel selector switches. The series bus goes through normally closed contacts on each channel switch to the ROAM ALL terminal. The parallel bus goes to normally open contacts on each channel switch. When a channel button is depressed while in the manual or roam mode, the normally closed contact in the series bus opens, disconnecting the ROAM ALL terminal from the CHAN COMM terminal. The normally open contact closes and the CHAN COMM terminal is connected to the selected channel element in the radio. In the manual mode, pressing a channel button selects the specific channel for completing calls. Since more than one channel button may be depressed when in the roam mode, all the buttons that are depressed connect the respective channel elements to the CHAN COMM terminal. This selects the channels over which the radio searches. If none of the channel buttons are depressed, the radio will search over all the channels.

When the H button is depressed, the CHAN COMM terminal is connected by wire jumpers to the channel elements in the home area. In this mode, all channels not in the home area are made inoperative by the removal of its respective jumpers.

For revertive call models only (with Party "P" button on control panel) the following will apply: If the P (party) button is depressed, a negative (-) voltage is applied to the coil of the party relay from the transmit key lead. With the relay energized, an additional set of contacts switches "A-" to the relay coil through the hook switch. This latches the relay until the call is completed, (handset returned to hook). While the relay is energized, the normal transmit key function is interrupted and the transmitter is operated from the P-T-T button. When the handset is returned to the cradle, the relay is de-energized and transmit control is returned to the supervisory unit.

REDUCTION OF INTERFERING NOISES IN MOBILE OPERATION

1. INTRODUCTION

Noise generated by the electrical system of the vehicle, as well as local ambient noise, may interfere with normal operation of two-way mobile radios. To overcome these interferences, various noise reduction procedures are required. These requirements vary from one vehicle to another, depending on the frequency of the system, the type of vehicle used, as well as the area the system is expected to cover. If the area to cover is sufficiently small so that signal levels may always be high, less noise reduction is required. Conversely, for maximum range coverage and operation into weak signal areas, noise reduction becomes very important.

Noise reduction is accomplished by proper bonding, filtering with coaxial capacitors, and miscellaneous techniques outlined in these instructions.

Before attempting any noise reduction procedures determine the noise source, then follow a systematic method of elimination until the interference is removed, or appreciably reduced.

2. NOISE REDUCTION KITS

Two noise reduction kits are available, one for vehicles with alternators and one for vehicles with generators. The kits are recommended for all 25-54 MHz radio installations because the noise problem is more severe than at higher frequencies. However, the kits are available for other radio sets if desired.

MODEL	APPLICATION
TLN8845A	Vehicles with alternators
TLN6252A	Vehicles with generators

3. GENERAL INFORMATION

Split-channel commercial two-way equipment will communicate as far as wide band equipment under no-noise conditions, but it is more susceptible to impulse noise interference. The useful range of split-channel two-way radio communications equipment can be seriously affected by noise interference, which prevents the reception of a clear easily understandable signal. A certain amount of noise interference may be tolerated when operating in a strong signal area or when operating a short-distance from the station. However, in weak signal areas such as fringe area operation, serious noise interference can cause a complete failure in the reception of the station signal.

4. RADIO FREQUENCY BANDS

The noise problem is generally more severe in the lower frequency communications band (25-54 MHz) but can also be troublesome in the 144-174 MHz bands and higher. However, ignition noise is seldom a problem above 450 MHz. Impulse noise is most noticeable in installations of narrow bandwidth receivers. Narrow bandwidth receivers are more susceptible to impulse noises because of the steep sided selectivity characteristics and not because of the method of obtaining the selectivity.

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However, for greater frequency spectrum utilization, it is necessary to reduce receiver acceptance bandwidths. As these acceptance bandwidths are reduced, the noise problems become greater. Therefore, in split-channel, low band (25-54 MHz) operation, it becomes essential to include noise reduction in all mobile installations.

Noise reduction requirements will vary widely with different vehicles, types of installation and types of system operation. System use and coverage often determine how much noise reduction is necessary. If the area coverage is sufficiently small so that signal levels may always be high, less noise reduction is required. Conversely, for maximum range coverage and operation in weak signal areas, it becomes necessary to do a very good job of reducing noise.

5. NOISE SOURCE

The source of noise can generally be determined by its sound in the speaker. For best results in locating noise, the unit should be receiving a weak signal which produces not less than 10 db nor more than 30 db noise quieting.

Noise interference is usually traced to one of the following sources:

a. Impulse noise interference generated by the vehicle electrical system. This type of interference is generated by commutator action (on vehicles equipped with generators), vibration of electrical contacts, and electrical arcing or sparking. This broadband interference may be propagated via space radiation.

The impulse noise enters the receiver through the antenna and serious interference in the form of tuned circuit "ringing" results even though the impulse may be very brief. "Ringing" may be defined as the shock excitation of a tuned circuit caused by an impulse which extends the duration of the impulse. It is this "ringing", caused by the impulse rather than the impulse itself, which is objectionable.

b. Noise produced by fluorescent lights, electric motors, electric fences, induction from power lines and similar sources is generally AM in nature, excluding capture effect. Normally, all such noise is removed from a received carrier by effective limiting action. Also, a vehicular radio is able to move out of a high noise level area if this type of noise interferes with reception. Thus, such conditions may be tolerated.

NOTE

Noise produced in the receiver, as well as ripple in the power supply, have been taken into consideration in the original design of the equipment. Any well designed mobile radio unit will not present any serious problems in this respect.

6. IGNITION NOISE

An automobile electrical system provides the primary source of electrical interference to radio communications in mobile installations. It can be generated by the spark plugs, distributor contacts, generator armature (on vehicles so equipped), voltage regulator, electrical gauges, wheel static and any part of the car where friction may exist due to intermittent contact between any two members of the car's mechanical structure.

In a mobile installation, the prime source of electrical interference with radio communications is in most cases the result of a spark discharge or arc created in the electrical system. Whenever a spark discharge takes place through air, high frequency oscillations are generated in a range of frequencies from a few kilohertz to hundreds of megahertz. These oscillations are generally radiated, however, they may be picked up by associated wiring and transferred to other electrical wiring in the system including that of the radio installation.

The problem of suppressing all the arcing that can develop in the electrical system may be difficult. For example, in an 8-cylinder engine operated at 2000 RPM, arcing in the engine system can be at the rate of 8000 sparks per minute or 133 per second. These arcs after being extended because of ringing, can create a blanket of noise blocking out weak signals at the radio receiver and only the very strongest signals are able to overcome such an obstacle.

7. THE IGNITION SYSTEM

To effectively reduce ignition interference in a car, the operation of an automobile ignition system should be understood.

The ignition system in a gasoline engine ignites the gasoline vapor and the air mixture in the cylinders. The system is made up of the battery, distributor, breaker points, coil, condenser and spark plugs. The battery is the only electrical source of power in an automobile.

Therefore, its low voltage must be stepped up to the high voltage necessary to develop arcs across the electrodes of the spark plugs. These arcs ignite the gas mixture.

The electrical circuit arrangement includes a mechanical circuit breaker (points in the distributor) which opens the primary circuit of the ignition coil. By transformer action in the coil, high voltage is developed at the coil secondary. This high voltage is applied and synchronized to each spark plug by the distributor.

As shown in Figure 1, the battery is connected to the primary winding of the coil through the ignition switch. The primary circuit is completed back to the battery through the breaker points, which are bypassed by the condenser. As the cam shaft is rotated by the engine, lobes or corners open and close the points in proper synchronism with each cylinder.

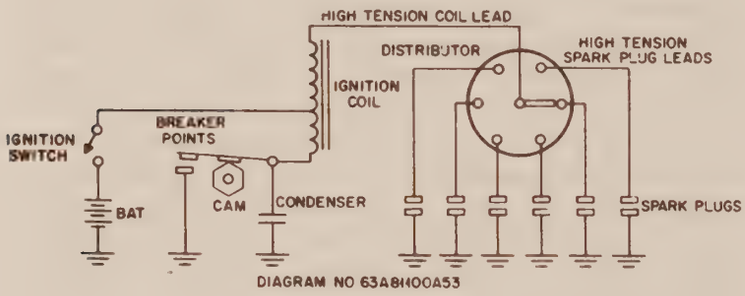


Figure 1.
Ignition Circuit

With the ignition switch on and the breaker points closed, as shown in the simplified schematic circuit in Figure 2, the primary current in the coil cannot build up rapidly, due to the self-inductance of the primary coil.

When the breaker points open, the primary current decreases almost instantly and an EMF is produced in the secondary by self-induction, which is many times greater than the battery voltage. When the breaker points open, the condenser reduces arcing of the points. Because of the stepped up ratio, the high voltage induced in the coil secondary causes a spark across the spark plug gap for a short interval of time.

The secondary circuit of the ignition coil, with the spark gap, is much like a spark transmitter used in the early days of radio. It is the heart of the ignition interference. All that is needed is an inductance and capacity in series with the spark gap. The lead inductance and stray capacity provide this tuned circuit. Because the discharge of the circuit is through a low resistance (ionized spark gap), the circuit tends to oscillate. The frequency of oscillation and the amplitude that is developed varies as the current changes in the spark gap. This oscillation in the high tension leads develops rf currents which can interfere with radio reception.

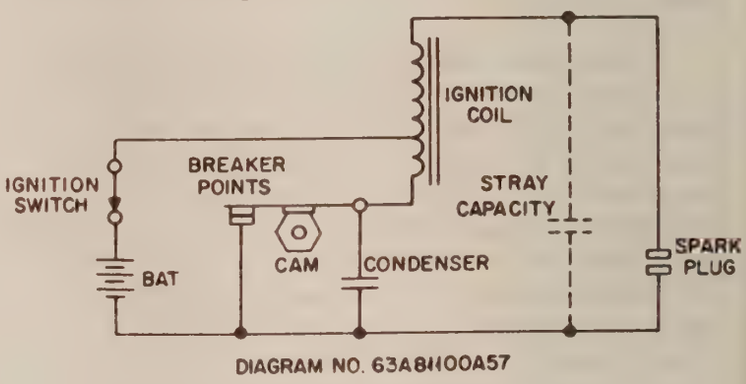


Figure 2.
Simplified Ignition Circuit

8. NOISE REDUCTION TECHNIQUE

It has long been known by ignition engineers that the addition of a series resistance adjacent to a spark discharge will serve to damp out the troublesome oscillation which causes interference. The types of spark plug suppression consistent with good engine performance to be applied in noise reduction should always be in accordance with the recommendations of the car manufacturer, i.e., if spark plugs are to be replaced with built-in suppressor types, they should be in the proper heat ranges and thread sizes for the particular engine. If resistance wire is used, the length may be critical so as not to exceed the total permissible resistance to be added. In addition to spark plug suppressors or resistance wire, an economical basic kit of noise reduction items can consist of the following: special coaxial capacitors, combinations of resistor and capacitor assemblies, and hood wiper springs.

The importance of such noise reduction items is greatly increased by their application at the right terminal points in the car's electrical system. Following is an outline of the important points to be considered and a step by step procedure in ignition noise reduction.

NOTE

Noise reduction can only be achieved if components are properly grounded. BE SURE THAT ALL CAPACITORS AND THE GENERATOR FIELD ASSEMBLY (if so equipped) ARE PROPERLY

NOTE (CONT'D)

GROUNDED. On some vehicles, standard bypass capacitors may already be installed at the locations referred to in these instructions. When these instructions call for coaxial capacitors, remove the standard bypass capacitor and mount the coaxial type per instructions.

In the development of a noise reduction kit, vas not deemed necessary to include a istance cable in the wiring harness. One or other of such items is generally found as a ndard part of present day motor vehicles. vever, the absence of such items from a basic se reduction kit is not to be misconstrued as ng non-essential to noise reduction. Spark plug se reduction is one of the most essential points e covered in all cases.

Generator Interference (Generator-Equipped Vehicles Only)

The generator is a source of electrical rference which is frequently blamed on the tion system. Electrical current passing veen the brushes and commutator in the erator creates many small arcs as the ar- ure rotates. Generator noise is characterized high pitched "whine" and varies with engine ed. A .5uF coaxial capacitor should be placed eries with the generator armature to reduce rference.

Voltage Regulator Interference

The voltage regulator is a precise mechanism aining three separate control systems operat- vith breaker contacts. Vibrating breaker acts cause arcing which may result in annoying rference. This interference is usually noted e form of erratic popping in the receiver h changes only slightly in frequency with ease in engine speed.

CAUTION

Disconnect the ground battery terminal from the battery before attempting to add any components to the battery terminal of the voltage regulator. Fail- ure to remove the battery ground connection may result in one or more blown fuses in some vehicles. Some voltage regulators have fuses as part of the regulator circuit.

To reduce voltage regulator hash noise, two .5uF coaxial capacitors and a resistor-capacitor assembly should be used. They are part of the TLN6252A Kit (8C82571B01 Coaxial Capacitor and 1V80700A89 Generator Field Suppression Assembly) or they can be ordered separately from the Motorola Parts Department.

NOTE

These capacitors are not required in alternator equipped vehicles.

c. Ignition Coil Interference

At the ignition coil, mount the 0.1 uF coaxial capacitor as follows:

(1) Ground the capacitor with one of the mounting bolts holding the ignition coil. Choose the mounting bolt that permits the most convenient wiring (see Figure 3.)

CAUTION

When tightening the nuts on the coaxial capacitor, be sure to hold the nut closest to the capacitor body firmly with an open-end wrench to prevent possible breakage of the capacitor seal.

(2) Disconnect the wire (or wires) from the primary (low voltage) terminal, battery side, of the ignition coil and reconnect it to one end of the 0.1 uF coaxial capacitor.

(3) Use the 5-inch lead with identical lugs on each end to connect between the other end of the capacitor and the primary (low voltage) terminal of the ignition coil.

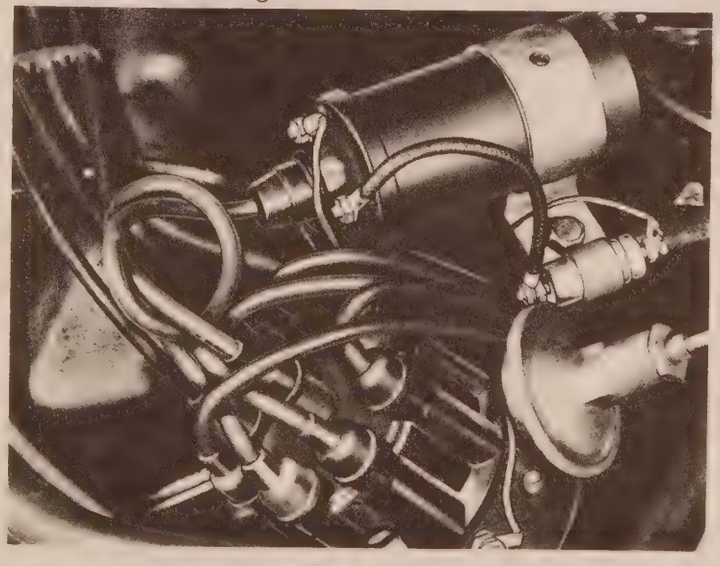


Figure 3.

IMPORTANT

Ordinary bypass capacitors should not be used in place of coaxial capacitors. The ordinary bypass capacitor displays a resonance effect with high rf noise attenuation, at about 2 megahertz. The coaxial type is non-inductive and provides high attenuation of rf noise up into the uhf region.

d. Distributor Interference

Sparking in the distributor itself is a source of radio interference. As the rotor rotates in the cap, sparking occurs between the rotor and the distributor cap inserts. To reduce the interference, a length of radio ignition wire connecting the ignition coil to the distributor cap has proven most effective. (See Figure 4.)

NOTE

If the vehicle is already equipped with radio ignition wire, the procedures of this paragraph are not necessary.

(1) Remove the ignition cable connecting the high voltage (secondary) terminal of the ignition coil to the distributor cap.

(2) Replace this lead with the suppressor cable supplied. If necessary, take up the slack by tying an overhand knot in this cable.

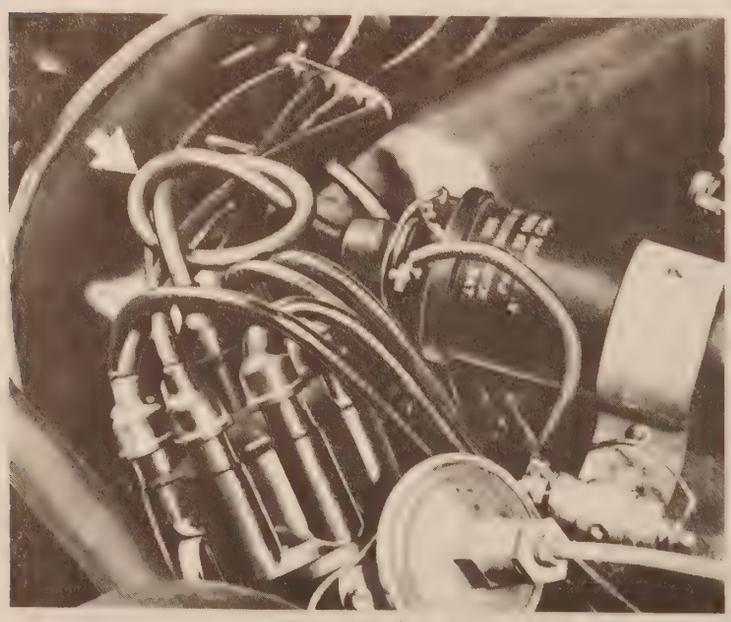


Figure 4.

e. Battery Connection

Connecting the radio primary power lead directly to the battery instead of the starter relay can help to keep noise off the "A" lead. The battery acts as a large capacitor (about 1 farad for 50 am capacity batteries) bypassing noise to ground This large capacitor serves as a very effective bypass. The battery ground return should also be bonded to the frame. Utilizing the car frame as a common ground as much as practical, tend to minimize the possibility of inducing undesirab parallel ground currents.

f. Hood Wipers

The ground returns for the electrical circui are provided through the body and frame of the automobile. Differences in conductivity, inadequ bonds between adjacent conductors and unequal current distributions result in potential difference throughout the vehicle. The miniature arcs create by these potential differences can be avoided by eliminating the potential differences. Effective use of copper bonding braid and brass contac wipers as hood bonds will minimize interference from this source.

For installation of the two hood wipers, proceed as follows:

(1) Mount the two hood wipers on the surface where the hood closes at the firewall. (See Figure

(2) Remove all paint from the body and hoo surfaces where electrical contact is to be made.

(3) Fasten with the two #8 self-tapping screws provided. (A #31 drill is recommended.)

(4) Bend the wipers by hand so that they make firm contact with the paint-free surface of the hood when the hood is closed.

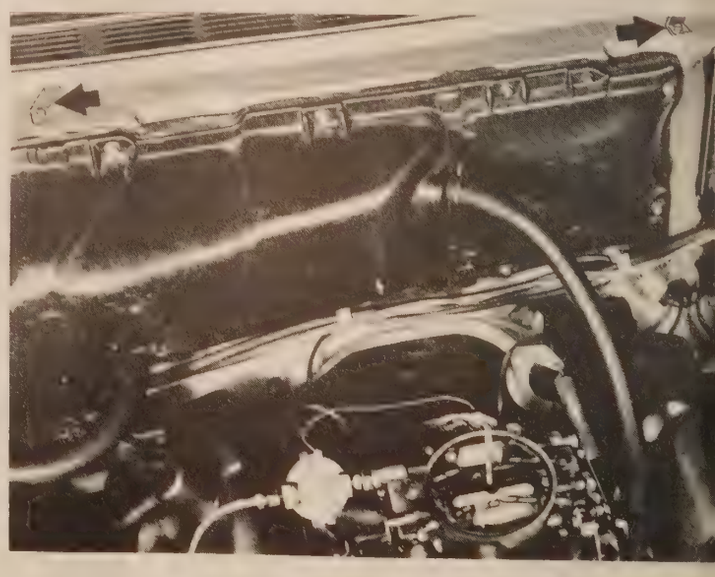


Figure 5.

g. Tagging Leads

A DO NOT REMOVE tag is included in the kit to alert the mechanics or technicians, not familiar with communications equipment, that a certain noise reduction component is essential for proper operation of two-way radio equipment.

Add the tag to the lead between the coaxial capacitor and ignition coil.

9. NOISE BALANCING IN RECEIVERS

Noise balancing a receiver may result in an appreciable amount of noise reduction. However, this method alone may not reduce all the apparent ignition noise.

It is characteristic of an FM receiver, that at one point in the alignment, a null point in impulse noise response will be reached. This null may vary from installation to installation. As the unit leaves the factory, the receiver is tuned to the exact operating frequency and is properly adjusted for proper noise balance. However, if it is found necessary to noise balance the receiver at some future date (as the set ages) or in some specific installation, the following procedure should be used:

Adjustments should be made with the receiver installed in the mobile vehicle and the vehicle engine running.

a. Turn the equipment "on" and allow it to warm-up for at least five minutes.

b. Turn up the volume to a normal listening level.

c. Radiate a signal on the frequency of the receiver. The signal can originate from a Motorola portable test set with a built-in crystal controlled peaking generator and correct channel crystal, from a signal generator, or from a distant transmitter.

The receiver should be on frequency. The receiver signal should be just strong enough to produce 10 to 30 db quieting.

d. Start the vehicle and let the engine idle.

e. Connect the portable test set to the receiver metering receptacle.

f. Place the selector switch of the test set in position 2.

g. Adjust any one of the first i-f coils until ignition noise is substantially reduced. The first i-f coils are very sensitive and may only be adjusted a very slight amount without reducing receiver gain. When making ignition noise balance adjustments, do not decrease the meter reading more than one-half microampere.

h. If satisfactory reduction of audible noise cannot be obtained by the methods previously described, the secondary winding of the discriminator is probably not aligned to exactly 455kHz. Align the discriminator as described in the receiver alignment procedures of the instruction manual.

10. ADDITIONAL NOISE REDUCTION TECHNIQUES

In some radio installations it may be necessary to obtain maximum noise reduction. In such installations, the following possible source of noise interference should be explored and the remedy applied.

NOTE

Add DO NOT REMOVE tags to all additional components if installed.

a. Ammeter to battery lead. (Bypass with .5 uF capacitor. Motorola Part No. 8A821889.)

b. Gauges, oil signal, gasoline and temperature. (Bypass with .5 uF capacitor. Motorola Part No. 8A821889.)

c. Ignition switch. (Bypass with .5 uF capacitor Motorola Part No. 8A821889.)

d. Headlight, tail light or dome light leads. (Bypass with .5 uF capacitor. Motorola Part No. 8A821889.)

e. Accessory wiring, electrical windshield wipers, heater motor, window openers and others. (Bypass with .5 uF capacitor. Motorola Part No. 8A821889.)

f. Wheel static. (Use wheel static collector rings on both front wheels.)

g. Acute cases of generator noise (in vehicles so equipped). (Install a .5 uF coaxial capacitor in series with the armature lead. Motorola Part No. 8C82571B01.)

h. For severe cases of ignition interference, Hallett Ignition Shielding Kits are available from

Motorola on separate order. These special shielded harnesses are available for most automobile and truck engines, providing improved communications in fringe areas and essentially waterproofing the ignition system. Supply the following information when ordering Hallett Ignition Shielding Kits:

1. Make and year of vehicle.
2. Auto or truck and number of cylinders.
3. Engine cubic inch displacement.
4. Type of ignition system; Auto-Lite, Chrysler, etc.

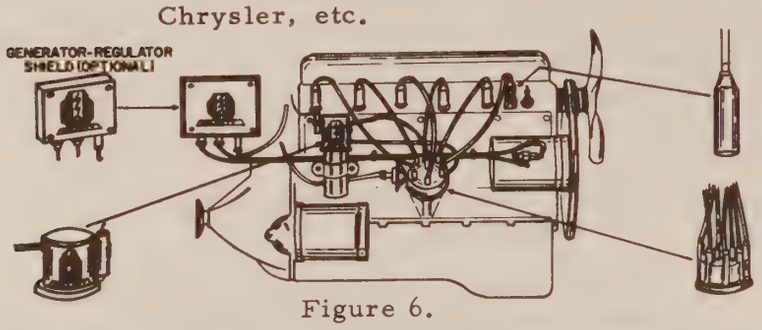


Figure 6.
Ignition Shielding Kit

NOTE

Fire truck engine shielding requires more detailed information to assist in supplying the proper kit. Write first for the special "fire truck shielding form" from your nearest Motorola Parts Depot.

11. CONCLUSION

The level to which ignition noise interference will need to be reduced will depend on the environmental conditions of operation of the radio system. The factors involved are the strength of the received carrier at various points within range of the fixed station, and the clarity of signals at the fringe areas. However, in most cases ignition noise interference can be substantially reduced resulting in optimum performance of the radio equipment under most operating conditions.

The reduction of ignition noise interference, in many cases, is essential to good system performance. Therefore, it must be given full consideration in the initial installation of the radio equipment. The components required to successfully reduce ignition noise interference may well prove to be an essential part of the communications system. Indeed, no installation of mobile radio can be complete unless the remedy for bothersome ignition noise interference has been successfully applied at the time of installation.

Specific noise sources may be isolated to some extent, under specific conditions. When the vehicle is standing still with the ignition switch off, any noise heard will probably be external to the vehicle. Static discharge noise will be added when the vehicle is moving with the ignition switch off. If the vehicle is coasting in gear, with the ignition switch off, generator noise will be added to the others, if present. Noise produced by inadequate bonding will be most noticeable when maximum current is being drawn from the battery, and may be increased when the vehicle is in motion. Care should be used to be sure that noise tests are made both with and without weak signals. Also, care should be used to check with the squelch control in the unsquelched or maximum sensitivity condition.

The use of a coaxial flexible lead, with a probe pick up loop of about one inch diameter, connected to a separate powered radio set or oscilloscope and utilized as a search wand to find the hottest areas, has been found to be most useful.

It is impossible to give an exact procedure to counteract noise in all cases; too many variables exist. With an understanding of some of the sources of noise, an intelligent approach will often save considerable time. Ignition noise reduction can add to both operational efficiency and operator satisfaction.

NOISE IDENTIFICATION AND REDUCTION CHART

Characteristics of Noise at Speaker	Source of Noise	How to Check Source of Noise	How to Reduce Noise
Identified as popping sound	Ignition	Noise varies in frequency with engine speed and will disappear when ignition is switched off.	1. Check to be sure: (a) Distributor breaker points are in good condition. (b) Ignition capacitor is in good condition. (c) All ignition system connections are free of corrosion & making good contact. (d) There is dc continuity in high voltage leads. (e) There are sufficiently high spark plug breakdown voltages. (f) Spark plug electrodes are properly spaced and in good condition. 2. Bond each corner of the motor block to chassis ground using a heavy copper grounding braid. 3. Damp the high voltage by installing a resistor suppressor in the distributor rotor lead, or suppressors in the ignition cables or on top of the spark plugs. 4. Install resistor spark plugs or resistance ignition cables.
Identified as a high pitched whine	Generator	Noise varies with engine speed and will persist if ignition is switched off while engine is running at a moderate speed.	Install a .5 uF coaxial capacitor at the generator in series with the armature lead.

NOISE IDENTIFICATION AND REDUCTION CHART (Cont'd)

Characteristics of Noise at Speaker	Source of Noise	How to Check Source of Noise	How to Reduce Noise
Identified as raspy sound	Voltage Regulator	Look for arcing voltage regulator contacts.	Install .5 uF coaxial capacitors, Motorola Part Number 8A821889 at the battery (BAT.) terminal in series with the battery lead and at the generator (ARM) terminal in series with the armature lead. Install RC Filter (1V80700A89) composed of a 3.3 ohm resistor in series with a .002 uF capacitor (maximum allowable capacity) in series with the field (F) terminal of the voltage regulator to a common ground.
Identified as a hissing or crackling sound	Gauges	Noise may be detected by jarring the individual gauges while the ignition is on.	Install .5 uF bypass capacitors where needed. (Motorola part #8A821889)
Identified as a low-pitch clicking sound	Oil Sender	Noise rate varies with oil pressure and stabilizes at point of maximum oil pressure.	Install .5 uF bypass capacitor (Motorola Part Number 8A821889) from gauge lead terminal on oil sender to chassis ground.
Identified as an irregular popping sound	Wheel Static	Noise disappears when brakes are lightly applied.	Install suitable grounding brushes or springs such as front wheel static eliminators (Motorola Part Number 1K534254 regular type, 1K563174 small type).
Identified as a more regular or sharper popping sound	Tire Static	Noise becomes much worse at 30-50 mph.	Use anti-static powder in tires with inner tubes.

12. KIT COMPLEMENT

a. TLN6252A Noise Reduction Kit

Reference Number	Quantity	Motorola Part Number	Description
1	3	1V839913	Lead & Lug Assembly
2	1	1V80700A88	Lead & Lug Assembly
3	1	8C82571B02	Capacitor, Coaxial (.1 uF - 100 V)
4	3	8C82571B01	Capacitor, Coaxial (.5 uF - 100 V)
5	1	1V80700A89	Generator Field Suppressor Assembly
6	1	30A502396	Ignition Coil Suppressor Cable
7		1V80700A91	Hood Wipers and Mounting Kit Hardware

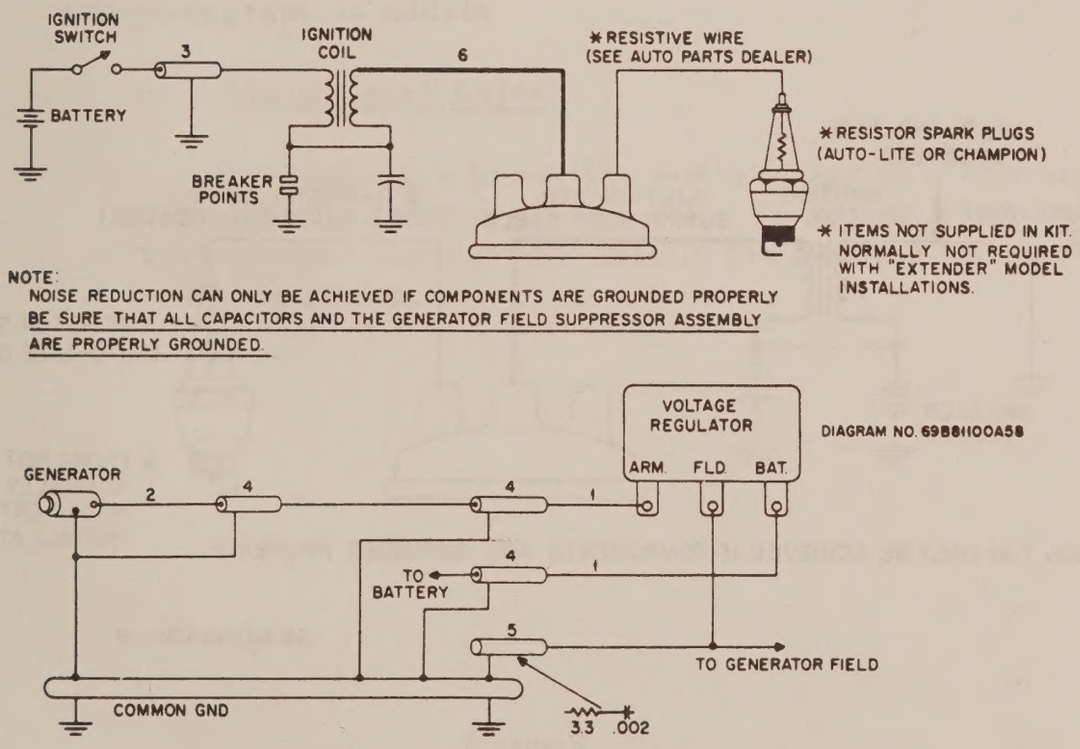


Figure 7.
Typical Noise Reduction Detail Using
TLN6252A Noise Reduction Kit

b. TLN8845A Noise Reduction Kit

Quantity	Motorola Part Number	Description
1	1V839913	Lead & Lug Assembly
1	8C82571B02	Capacitor, Coaxial (.1 uF, 100 V)
1	30A502396	Ignition Coil Suppressor Cable
1	1V80782A52	Hood Wipers and Mounting Hardware Kit

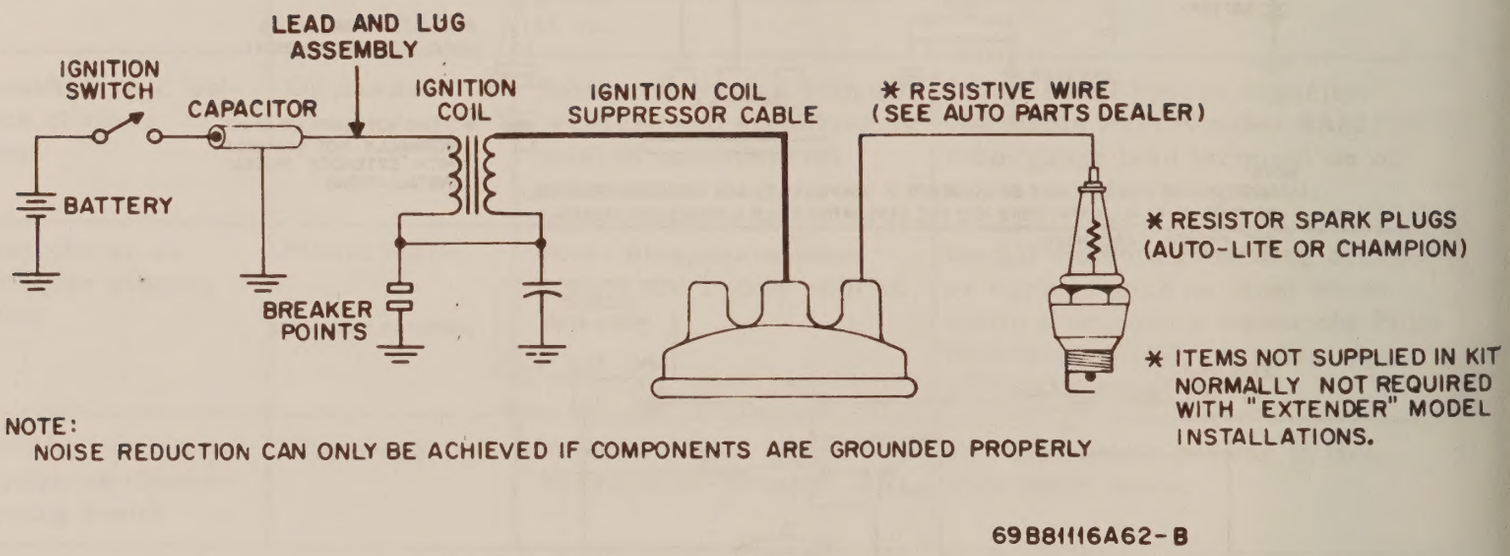


Figure 8.
Typical Noise Reduction Detail Using
TLN8845A Noise Reduction Kit

MOTOROLA

INSTRUCTION MANUAL REVISION

SMR-2028A

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUAL AFFECTED:

68P81021A15-F 152-162 MC IMTS Car Telephone FM Radio

REVISION DETAILS:

In the INSTALLATION AND OPERATION section, page 3, the following sub-paragraph is added:

e. Audio Level Adjust

It is possible to set the audio output at a comfortable level by adjusting volume control R1. To adjust R1, insert a small screwdriver through the hole in the housing located below the left hookswitch.

SMR-2028A
4/11/74